



Massachusetts Military Reservation

PLUME RESPONSE PROGRAM

DRAFT FS-12 CONTAINMENT SYSTEM VOLUME 3 TECHNICAL SPECIFICATIONS

October 1996

*Prepared by:
Jacobs Engineering Group Inc.*

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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

- H. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with fill and compact to density equal to or greater than requirements for subsequent backfill materials.
- I. Prior to placement of aggregate base course material at paved areas, compact subsoil to 95 percent of its maximum dry density in accordance with ASTM D698.

3.2 Examination

- A. Verify fill materials to be reused are acceptable.
- B. Verify foundation perimeter drainage installation has been inspected.

3.3 Excavation

- A. All excavations shall be protected and guarded against danger to life and property and shall conform to OSHA "Construction Standard for Excavations" (29 CFR Part 1926.650-.652, Subpart P). Permanent excavations or fill shall have retaining walls sufficient in strength to retain the embankment, together with any surcharge loads, unless the sides slope sufficiently for this retention.
- B. Excavate subsoil required to accommodate building foundations, paving and site structures and construction operations.
- C. Excavate to working elevation(s). Coordinate special requirements for piling.
- D. Machine slope banks to angle of repose or less, until shored.
- E. Excavation cut not to interfere with normal 45° bearing splay of foundation.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

- F. Grade top perimeter of excavation to prevent surface water from draining into excavation. Any water that does accumulate in an excavation during working hours shall be removed continuously or as a significant accumulation occurs. Overnight accumulation shall be removed immediately at the beginning of the work day. The Contractor shall provide temporary pumping facilities to drain the water to the nearest catch basin or drainage ditch.
- G. Hand trim excavation. Remove loose matter.
- H. Remove lumped subsoil, boulders and rock.
- I. Hand excavation shall be required around any below grade piping or other utilities. Support piping and other utilities which could be damaged by excavation work. Any piping or pipe coating that is damaged shall be repaired at the Contractor's expense.
- J. If underground obstructions, piping or other utility services are encountered which are not indicated on the drawings or in the specifications, instructions shall be obtained from the Engineer before proceeding.
- K. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- L. Correct unauthorized excavation at no extra cost to Owner.
- M. Correct areas over-excavated by error by placing lean concrete in the excavation to the correct elevation.
- N. Stockpile excavated material in area designated onsite and remove excess material not being reused from site.

3.4 Backfilling

- A. Backfill areas to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

C. Granular Soils Fill

Place and compact materials in continuous layers not exceeding six inches compacted depth.

D. Compact granular backfill that is insensitive to compaction moisture to an in-place density of at least 70 percent relative density, as defined in ASTM D4253 and ASTM D4254.

E. Cohesive Soils Fill

Place and compact material in continuous layers not exceeding 8 inches compacted depth.

F. Clayey sands and cohesive soils that are sensitive to compaction moisture shall be placed and compacted to at least 95 percent of the Standard Proctor maximum density determined in accordance with Method A of ASTM D698. Moisture content of the fill shall be controlled within ± 2 percent of optimum moisture.

G. Upon placement and compaction of each lift of cohesive material, the surface shall be scarified to a depth of two inches prior to the placement of subsequent lift.

H. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation waterproofing and protective cover utilities in trenches.

I. Maintain optimum moisture content of backfill materials to attain required compaction density.

J. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.

K. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

- L. Slope grade away from building minimum two inches in 10 feet, unless noted otherwise.
- M. Make grade changes gradual. Blend slope into level areas.
- N. Remove surplus backfill materials from site.
- O. Leave fill material stockpile areas completely free of excess fill materials.

3.5 Tolerances

A. Top Surface of Backfilling

Plus or minus one inch from required elevations.

3.6 Field Quality Control

- A. The Contractor shall conduct field density tests during backfill and fill placement. The tests shall be performed by qualified Soil Technicians working under the direction of a Soils Engineer registered in the state where the project is located.
- B. Field density tests shall be performed in accordance with ASTM D2922, D1556 or D2167.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.
- D. Frequency of Tests
 - 1. Every 50 cubic yards of fill or backfill in trenches or around structures.
 - 2. Every 200 cubic yards for embankment, dike or other mass earthwork.
 - 3. At least one test shall be made for every full day of compaction operations on mass earthwork.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

4. One test whenever there is a definite change in the quality of moisture control or effectiveness of compaction.

E. Proof roll compacted fill surfaces under slabs-on-grade paving.

3.7 Protection of Finished Work

A. Recompect fills subjected to vehicular traffic.

B. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.

C. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

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DIVISION 1



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 01010		
			SPECIFICATION FOR SCOPE OF WORK		
BY BB	APPROVED <i>GR Thomas</i>	ISSUE DATE 8/22/96			
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BB	<i>g. j. h. h. h.</i>	8/22/96	0	8/22/96		

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 The work to be performed under these Specifications and Contract Drawings entitled MMR - Plume Response Projects consists of furnishing all materials, equipment and tools, and performance of all necessary labor for the complete construction of the required groundwater extraction, treatment and reinjection facilities.

1.1.2 The work will be performed at or in close proximity to the Massachusetts Military Reserve, (MMR) Otis ANGB, Massachusetts.

1.1.3 The work includes, but is not limited to:

- A. Supply of all labor, services, equipment, and supplies to execute a performance level project to extract and treat contaminated groundwater from the designated plumes and reinject the treated water.
- B. Preparation and submittal of operation and maintenance manuals for all equipment installed as part of the project.
- C. Provide operation and maintenance services for a period of 12 twelve months commencing on the day following Owner/Engineer acceptance of the entire project.
- D. Operation and maintenance training for the Owner's operating staff. O&M training required by the contractor for operators should be a minimum of 40 hours, with an additional 16 to 24 hours for each treatment unit.

1.1.4 Construction activities shall be completed within the designated schedule time after receipt of the Owner/Engineer's Notice to Proceed. Facilities will be placed in service as they are completed and partially accepted. Prior to starting construction, the Contractor shall submit a revised Project Schedule (based on requirements in Section 01300, Submittals, in accordance with the Contract Documents. Upon the completion of construction the Contractor shall demonstrate to the Owner that all equipment and installations are fully operational in accordance with the requirements of Section 01700, Contract Close-out.



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SPECIFICATION FOR SCOPE OF WORK

1.0 **GENERAL** (continued)

1.2 PROJECT REQUIREMENTS

1.2.1 The work shall be constructed in strict conformance with applicable federal, state, and local regulations. The MMR site is a federal Superfund project and the Work will be performed under the guidance of the United States Environmental Protection Agency (USEPA) and Massachusetts Department of Environmental Protection (MDEP).

2.0 **PRODUCTS**

2.1 The Contractor will be required to supply all specified products, materials, and equipment required for the installation of the Work.

3.0 **EXECUTION**

3.1 ACCESS

3.1.1 Access to the MMR site is restricted. It is necessary for the Contractor to make provisions with the Owner/Engineer to gain access to the site. Unless arrangements have been made by the Contractor, MMR site access will be denied.

3.2 DAMAGE TO EXISTING SYSTEMS

3.2.1 If, during the construction, the Contractor damages equipment or systems at the site, the Contractor shall be required to repair the damage by the end of the working day or as approved by the Owner/Engineer. If, in the opinion of the Owner, the repair is not progressing in a timely fashion, the Owner may hire a subcontractor to complete the repair work. All costs for the repair (including subcontractor costs) shall be the responsibility of the Contractor.

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 01041		
			SPECIFICATION FOR PROJECT COORDINATION		
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1.0 GENERAL

1.1 DESCRIPTION

1.1.1 The Contractor shall be responsible for the following:

- A. Coordinate all activities with the Owner/Engineer and any other contractor performing work at the site.
- B. Obtain all necessary construction permits.
- C. Make arrangements for temporary storage of materials and supplies and for their delivery to the job site.
- D. Assist the Owner/Engineer as required in the review of construction and the testing of materials.
- E. Maintain current progress records and record drawings.
- F. Maintain the project housekeeping at all times.
- G. Coordinate with all utilities, and coordinate with Owner/Engineer when excavation is scheduled in areas that may affect existing utilities prior to commencing excavation.
- H. Coordinate the work subcontractors, equipment, and material suppliers.
- I. Conduct all site work in accordance with the requirements of the Air Force Facility Safety & Health Plan (AFFSHP).
- J. Hold a preconstruction conference to discuss construction sequencing work procedures, quality control, documentation, health and safety, housekeeping, communications and other pertinent issues.
- K. Conduct regulation safety and progress meeting throughout the construction period.



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SPECIFICATION FOR PROJECT COORDINATION

1.0 GENERAL (continued)

1.1.2 Priority for conflicting construction and monitoring activities will be determined by the Owner/Engineer.

1.1.3 Any delays and associated costs due to conflicting construction activities will be borne by the Contractor/Contractors.

1.2 RELATED SECTIONS

Section 01300 - Submittals

Section 01600 - Materials and Equipment

2.0 PRODUCTS

(Not Used.)

3.0 EXECUTION

(Not Used.)

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00				NO. 01060	
BY BB		APPROVED <i>JR Thomas</i>	ISSUE DATE 8/19/96	SPECIFICATION FOR REGULATORY REQUIREMENTS	
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<p>1.0 GENERAL</p> <p>1.1 DESCRIPTION</p> <p>1.1.1 All project related work shall comply with applicable provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA) and the National Oil and Hazardous Substances Contingency Plan (NCP).</p> <p>1.2 ON-SITE WORK</p> <p>1.2.1 On-site activities will include but not necessarily be limited to the following regulations:</p> <ul style="list-style-type: none">A. OSHA - Occupational Health and Safety Standards (29 CFR Part 1910)B. OSHA - Recordkeeping and Reporting (29 CFR 1904)C. OSHA - General Industry Standards (29 CFR 1926)D. CAA - National Ambient Air Quality Standards (NAAQS)E. MAPCR - Massachusetts Ambient Air Quality Standards (310 CMR 6.00)F. CWA - Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)G. CWA - National Pollution Discharge Elimination System (NPDES) Requirements (40 CFR 122)H. Massachusetts Implementation of MGL, Chapter 111F, Employee and Community Right-to Know (310 CMR 33.00)I. Massachusetts Worker Right-to Know (441 CMR 21.00)J. SDWA - Maximum Containment Levels (40 CFR 141-143 and 310 CMR 22.00)K. SDWA - Underground Injection Control (40 CFR 144-147 and 310 CMR 27.00)						



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SPECIFICATION FOR REGULATORY REQUIREMENTS

1.0 GENERAL (continued)

L. Wetlands - (16 USC 661, 40 CFR 230, 40 CFR 6, and 310 CMR 10.00)

M. RCRA - Hazardous Waste Management Requirements (40 CFR 264-265 and 310 CMR 30)

1.3 TRANSPORTATION

1.3.1 Waste/Material transportation regulations will include, but not necessarily be limited to the following:

A. Department of Transportation (DOT), Rules for the Transportation of Hazardous Materials (49 CFR 171).

1.4 OFF-SITE TREATMENT DISPOSAL

1.4.1 Regulation applicable to off-site treatment and disposal of hazardous wastes, if required, will include but not necessarily be limited to the following:

A. RCRA - Hazardous Waste Management (40 CFR 264 and 310 CMR 30)

B. RCRA - Land Disposal Restrictions (40 CFR 268)

2.0 PRODUCTS

Not Used

3.0 EXECUTION

Not Used

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1.0 GENERAL

1.1 DESCRIPTION

1.1.1 This section covers the general requirements and procedures for submittals. The following items are covered in this section:

- A. General Submittal Requirements
- B. Submittal Form
- C. Items Requiring Submittal for Approval
- D. Construction Progress Schedule
- E. Progress Reports
- F. Product and Equipment Data
- G. Manufacturers' Equipment Operating Instructions
- H. Shop Drawings
- I. Procedures and Methods
- J. Contractor's Responsibilities
- K. Record Drawings

1.1.2 In this specification, the word "Contractor" shall denote contractors, subcontractors, manufacturers, fabricators, suppliers, or any other provider of equipment or services for which documentation is required.

1.2 GENERAL SUBMITTAL REQUIREMENTS

1.2.1 The Contractor shall deliver submittals to the Owner/Engineer on or before the approved deadline dates.

Submittals for fabricated or manufactured items shall be in accordance with Jacobs Appendix "E", Vendor Data and Drawing Request form.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

1.2.2 The submittal procedure shall be in accordance with the following:

- A. Transmit a Submittal Form and cover letter with each submittal and revision to the Owner/Engineer with one (1) reproducible and four (4) copies of every page of the submittal.
- B. Transmittal forms and each page of the submittal shall have a unique submittal number.
- C. Sequentially number the submittals. Resubmittals shall have the original number with an alphabetic suffix (A, B, C, etc.) to indicate the sequence of the resubmittal.
- D. The Owner/Engineer will not accept submittals from anyone but the Contractor.
- E. Contractor shall certify that submittals are in compliance with the Contract Documents.

1.2.3 The Owner/Engineer's submittal review period shall be 14 consecutive calendar days in length and shall commence on the first calendar day immediately following the date of arrival of the submittal or resubmittal in the Owner/Engineer's office. The time required to mail the submittal or resubmittal back to the Contractor shall not be considered as part of the submittal review period.

1.2.4 The Owner/Engineer's review of the submittal (including drawings, data and samples) will cover only general conformity to the Contract Drawings and Specifications, external connections, and dimensions that effect the layout. The Owner/Engineer's review does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, device or item shown. The Owner/Engineer's review of submittals shall not relieve the Contractor from responsibility for errors, omissions, or deviations, nor responsibility for compliance with the Contract Documents.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

1.2.5 The Contractor shall check and review the submittals returned for correction, and ascertain whether the required corrections result in extra cost above that included in the Contract, and give written notice to the Owner/Engineer within five working days, if, in the Contractor's opinion, extra costs result from the corrections. The Contractor's failure to give such written notice or the starting of the Work covered by returned submittal constitutes a waiver by the Contractor of claims for extra costs resulting from required corrections.

1.2.6 The Contractor shall make all required corrections and/or changes in the submittals and resubmit one (1) reproducible and four (4) copies to the Owner/Engineer for approval. Samples of the products or materials may also be requested by the Owner/Engineer to aid the review process.

1.2.7. The need for review of more than one resubmittal, or any other delay in obtaining the Owner/Engineer's approval will not entitle the Contractor to extend the Contract Time unless delay of the Work is directly caused by a change in the Work authorized by a Change Order, or by failure of the Owner/Engineer to review a submittal and return the submittal to the Contractor within the review period set forth herein.

1.2.8 All costs for the preparation, correction, samples, and delivery of the submittals shall be borne by the Contractor.

1.2.9 Any exceptions taken to the data or drawings required by Appendix "E" or by the requisition documents shall be stated in the Contractor's proposal.

1.3 SUBMITTAL FORM

1.3.1 Each submittal and revision shall be accompanied by a Submittal Form with all appropriate items completed.

A. Submittals will not be approved without an appropriately completed Submittal Form.

B. A sample submittal form is included as Attachment 1.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

1.4 ITEMS REQUIRING SUBMITTAL FOR APPROVAL

1.4.1 Items that are required to be submitted by the Contractor for approval include:

- A. Construction Progress Schedule and Progress Report
- B. Product Data
- C. Equipment Data
- D. Manufacturer's Operating Instructions
- E. Shop Drawings
- F. Procedures and Methods
- G. Control System Programming of vendor package equipment

1.5 CONSTRUCTION PROGRESS SCHEDULE

1.5.1 The Contractor shall provide a Preliminary Construction Schedule for the Scope of Work. The Preliminary Construction Schedule shall be submitted with the Bid Schedule.

1.5.2 The Contractor shall, within ten calendar days after receipt of Notice to Proceed, provide and submit to the Owner/Engineer for approval, the "Final Construction Schedule" for his planned operations, and general approach for completion of the Work. The Final Construction Schedule shall graphically show the order and interdependence of all activities necessary to complete the Work, and the sequence in which each activity is planned to be accomplished including start and finish dates for each task or activity. The Contractor shall include in the Final Construction Schedule the activities of all trades, subcontractors, and material suppliers. The Engineer shall approve the Final Construction Schedule before any construction begins.

1.5.3 Weekly, the Contractor shall monitor, update, and submit an up-to-date version of the Final Construction Schedule to the Owner/Engineer. The revised schedule shall clearly show actual progress, revised milestones, completed activities, partially completed activities, and future activity completion dates.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

A. All activities that are behind schedule shall be identified and reported as to the effect to the future activities and overall schedule.

B. All activities that change from the previously approved schedule in method, labor intensity or rate of productivity will be identified and the changes discussed.

C. Restraints imposed by delayed material deliveries shall also be identified and discussed.

1.5.4 The Contractor shall participate in the Owner/Engineer's review and evaluation of the revised Schedule and shall make all revisions to the schedule in accordance with the review comments, and resubmit it to the Owner/Engineer for approval. The approved schedule shall then be used by the contractor for planning, organizing, and directing the Work and for reporting progress.

1.5.5 The Contractor shall work diligently to complete the activities or portions of the Work in a timely manner, so that no delay will be caused to other Work activities.

1.6 PROGRESS REPORTS

1.6.1 A progress report shall be furnished to the Owner/Engineer with each application for progress payment. If the Work falls behind schedule, the Contractor shall submit additional progress reports at such intervals as the Owner/Engineer may request.

1.6.2 Each progress report shall include sufficient narrative to describe work completed to date and, if necessary, anticipated delaying factors, their effect on the Final Construction Schedule, and proposed corrective actions. Any portion of the Work reported to be complete, but which is not readily apparent as complete to the Owner/Engineer, must be substantiated with satisfactory evidence.

1.6.3 Each progress report shall also include three copies of the accepted schedule marked to indicate actual progress.

1.7 PRODUCT DATA

1.7.1 Within ten days after the date of Notice to Proceed, the Contractor shall submit a complete list of major products to be used.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

1.7.2 A submittal form shall be submitted for each group of products, including the uses and manufacturers name and address. For each item listed, include the trade or brand name, product number, guarantees/warranties, reference standard, installation instructions, and any supplemental technical data or information that may be required for approval.

1.8 EQUIPMENT DATA

1.8.1 Within ten days of date of Notice to Proceed, the Contractor shall submit a complete list of equipment to be installed.

1.8.2 A submittal form shall be submitted for each separate mechanical and electrical equipment, including the use of and manufacturers name and address. For each item, include the model number, technical data, performance information, ratings, capacities, guarantees/warranties, reference standards, installation instructions, and any other information that may be required for approval.

1.9 MANUFACTURERS' EQUIPMENT OPERATING INSTRUCTIONS

1.9.1 The Contractor shall supply the Owner/Engineer with ten (10) manuals containing equipment operating instructions for all assembly items identified on the Contract Drawings and for all components that are included in the electrical systems and any other items supplied by the Contractor.

1.9.2 Three preliminary copies of each manual shall be submitted to the Owner/Engineer for review prior to completion of the construction. After approval by the Owner/Engineer, ten (10) final copies of each manual shall be prepared and delivered to the Owner/Engineer not later than seven days prior to placing the equipment in operation.

1.9.3 The Operating Instruction Manual shall include the following:

- A. Manufacturers' literature describing equipment function, normal operating characteristics, and limiting conditions.
- B. Assembly, installation, alignment, adjustment, calibration and checking instructions.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

C. Operating instructions for startup, routine and normal operation, regulation and control and shutdown.

D. Lubrication and maintenance instructions.

E. Guide to "troubleshooting".

F. Parts lists and predicted life of parts subject to wear.

G. Manufacturers' recommended spare parts list.

H. Outline, cross sections, and assembly drawings; operating data; and wiring diagrams.

I. Test data and performance curves, where applicable.

J. Any vendor programming of their packaged system controls.

1.9.4 The Operating Instruction Manuals shall be in addition to the instructions or parts lists packed with or attached to the equipment when delivered.

1.9.5 All manuals shall be bound in appropriately sized, white, clear-view three-ring or three-post binders. The following list of information shall be provided and attached to the inside of each binder front cover:

Project Owner: Massachusetts Military Reserve
Project Location: Otis ANGB, Massachusetts
Project Title: MMR Plume Response Projects
Contractor Name: Name of Contractor
Engineer: Jacobs Engineering Group, Inc.
Title: Manufacturers' Equipment Operating Instructions
Date: Date Submitted

1.9.6 Manufactures' manuals and other data shall be original operating instructions as printed by the manufacturer or if these are not available, they shall be printed on white heavy, first quality or recycled 24 pound bond paper, 8-1/2 by 11-inches or 11 by 17-inches. Where reduction is not practical, larger Drawings shall be folded separately and placed in clear plastic packets which are bound into the Manuals. Each clear plastic pocket shall bear suitable identification of its contents.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

1.9.7 All materials shall be marked with project identification. Inapplicable information shall be marked out or deleted. Sales literature shall not be substituted for operating instructions.

1.9.8 Shipment or installation of equipment will not be considered complete until all required manuals and data have been received.

1.9.9 Each item in the manual must also identify the model number of the item supplied and either its P&ID name or its location.

1.10 SHOP DRAWINGS

1.10.1 Shop Drawings, as may be specified in individual work sections include, but are not limited to, custom-prepared data such as fabrication and erection/installation Drawings, schedule information, setting diagrams, actual manufacturers' instructions, custom templates, special wiring diagrams, coordination Drawings, system or equipment inspection procedures and testing and verification reports including performance curves and certifications, as applicable to the Work.

1.10.2 All shop Drawings submitted by subcontractors for approval shall be sent directly to the Contractor for preliminary checking. The Contractor shall be responsible for their timely submission so as to prevent delays in delivery of materials.

1.10.3 The Contractor shall check all subcontractors' shop Drawings regarding measurement size of individual members, materials, and details to satisfy that they conform to the intent of the Contract Drawings and these Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the appropriate subcontractor for correction before submission thereof.

1.10.4 All details on shop Drawings submitted for approval shall show clearly the relation of the various parts to the main members and lines of the structure, and where correct fabrication of the Work depends upon field measurements, such measurements shall be made and noted on the submittal Drawings before being submitted for approval.



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SPECIFICATION FOR SUBMITTALS

1.0 GENERAL (continued)

1.11 PROCEDURES AND METHODS

1.11.1 Within ten days after date of Notice to Proceed or at least one month prior to the application, the Contractor shall submit specific procedures and methods in order to meet the Contract Documents.

1.11.2 Specific procedures and methods that will require submittals include, but are not limited to pipe pressure testing, liner testing and fabricating, concrete curing and surface collector installation.

2.0 PRODUCTS

Not Used.

3.0 EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITIES

3.1.1 The Contractor shall review shop Drawings, product data and samples prior to submitting them to the Owner/Engineer. As a minimum, the Contractor shall determine and verify the following, as applicable:

- A. Field measurements
- B. Field construction criteria
- C. Catalog numbers and similar data
- D. Conformance with the Specifications

3.1.2 The Contractor shall provide with each shop drawing, working drawing, sample and catalog data submitted to the Owner/Engineer a signed certificate stating that he has determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and has checked and coordinated each item with other applicable approved shop Drawings and all contract requirements.



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3.0 EXECUTION (continued)			
3.1.3 The Contractor shall notify the Owner/Engineer in writing, at the time of submittal, any deviations in the submittals from the requirements of the Contract Documents.			
3.1.4 The review and approval of shop Drawings, samples or catalog data by the Owner/Engineer shall not relieve the Contractor from his responsibility to fulfill the terms and conditions of the contract. All risks of error and omission are assumed by the Contractor and the Owner/Engineer shall therefore have no responsibility therefore.			
3.1.5 No work requiring a shop drawing, working drawing, sample, or catalog data shall start, nor shall any materials be fabricated or installed prior to their approval by the Owner/Engineer. Fabrication performed, materials purchased or onsite construction accomplished that does not conform to approved shop Drawings and data shall be at the Contractor's risk. The Owner shall not be liable for any expense or delay due to correction or remedies required to accomplish conformity.			
3.1.6 All work, materials, fabrication, and installation shall conform with approved shop Drawings, working Drawings, applicable samples, and catalog data.			
3.2 RECORD DRAWINGS			
3.2.1 The Contractor shall maintain onsite a set of up-to-date Record Drawings, which clearly indicate all changes to the Contract Drawings. The Record Drawings shall indicate all changes to the original contract Work and additional Work in red. The Record Drawings shall also indicate exact routing of all power and control wiring, locations of all manual and automatic controls and amperage readings for all motors taken at the equipment under normal load conditions.			
3.2.2 A complete and accurate set of Record Drawings shall be signed and dated by the Contractor and shall be labeled with the following, "These Record Drawings completely and truly represent the contract Work as installed."			
3.2.3 Record Drawings shall be delivered to the Owner/Engineer prior to final approval of the Work.			
3.2.4 Record Drawings shall include the name, address, phone number, and signature of the Contractor and any subcontractors.			



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<p>3.0 EXECUTION (continued)</p> <p>3.2.5 The cost for Record Drawings shall be included in the Contractor's total bid price.</p> <p>3.2.6 Approval of the installation documentation and Record Drawings shall be a prerequisite for final payment.</p> <p>3.2.7 Record Drawings shall show all deviations in "clouds" to clearly identify any deviations from the Contract Drawings.</p> <p>3.2.8 All utilities encountered during construction shall be shown on Record Drawings. Any utility locations that are different than those shown on the Drawings shall be clearly identified in their correct locations.</p>			

SUBMITTAL FORM

Submittal No. _____

Project Title: _____

Resubmittal Date: _____

Contractor Performing Work: _____

Initial Submittal Date: _____

Item and Use:

Trade Name: _____

Product Name: _____

Plan No.: _____

Specification Section: _____

Contractor/Supplier/Manufacturer, Name and Address

Relevant Standard or ASTM

Equipment and Product Data Attached: Other Attachments -

_____ Shop Drawings

_____ Material Lists

_____ Sample

_____ Catalogs and Brochures

_____ Technical Data

_____ Performance Data

_____ Guarantee/Warranty

_____ Certificates

_____ Manufacturer's Instructions

ENGINEER INITIAL

APPROVAL _____

NEEDS REVISION _____

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 01600		
			SPECIFICATION FOR MATERIAL AND EQUIPMENT		
BY	APPROVED	ISSUE DATE			
BB	<i>GR Thomas</i>	8/19/96			
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					SPECIFICATION FOR MATERIAL AND EQUIPMENT	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
BB	<i>JR Thomas</i>	8/19/96	0	8/19/96		

1.0 GENERAL

1.1 DESCRIPTION

This section covers packing and shipping receiving, unloading, examination, storage and protection of materials and equipment required for this project.

1.2 RELATED SECTIONS

Section 01041 - Project Coordination

1.3 PRODUCTS

1.3.1 Includes new material, machinery, components, equipment, fixtures, and systems forming the work. Machinery and equipment used for preparation, fabrication, conveying, and erection of the work are not included. Products may also include existing materials or components required for reuse.

1.3.2 Do not use materials and equipment removed from existing structures, except as specifically required or allowed by Contract Documents.

1.4 TRANSPORTATION AND HANDLING

1.4.1 Transport and handle products in accordance with Manufacturer's instructions.

1.4.2 Promptly inspect shipments upon receipt to assure that products comply with requirements, quantities are correct, and products are undamaged.

1.4.3 Provide equipment and personnel to handle products by methods to prevent soiling or damage.

1.5 STORAGE AND PROTECTION

1.5.1 Store products in accordance with Manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weathertight enclosures; maintain within temperature and humidity ranges required by Manufacturer's instructions.

1.5.2 For exterior storage of fabricated products, place on sloped supports above ground.



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SPECIFICATION FOR MATERIAL AND EQUIPMENT			
<p>1.0 GENERAL (continued)</p> <p>1.5.3 Provide off-site storage and protection when site does not permit on-site storage and protection.</p> <p>1.5.4 Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.</p> <p>1.5.5 Store loose granular materials on solid surfaces in a well-drained area; prevent mixing with foreign matter.</p> <p>1.5.6 Provide equipment and personnel to store products using methods that prevent soiling, disfigurement or damage.</p> <p>1.5.7 Arrange storage that provides access for inspection. Periodically inspect to assure products are undamaged and are maintained under the required conditions.</p> <p>2.0 PRODUCTS</p> <p>(Not used.)</p> <p>3.0 EXECUTION</p> <p>3.1 PACKAGING, TRANSPORTATION</p> <p>3.1.1 Require supplier to package products in boxes or crates for adequate protection during shipment, handling, and storage. Protect sensitive products against exposure to the elements.</p> <p>3.1.2 Protect sensitive equipment and finishes against impact, abrasion, and other damage.</p> <p>3.2 DELIVERY AND RECEIVING</p> <p>3.2.1 Arrange deliveries of products in accordance with construction progress schedules. Allow time for inspection prior to installation.</p> <p>3.2.2 Coordinate deliveries to avoid conflict with other work at the site, limitations on storage space, availability of personnel and handling equipment and other site activities.</p> <p>3.2.3 Deliver products in undamaged, dry condition, in original unopened containers or packaging with identifying labels intact and legible.</p>			



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SPECIFICATION FOR MATERIAL AND EQUIPMENT

3.0 EXECUTION (continued)

3.2.4 Clearly mark partial deliveries of component parts of equipment in a manner that identifies equipment and contents to allow easy accumulation of parts and to facilitate assembly.

3.2.5 Immediately on delivery, inspect shipment to assure:

- A. Product complies with requirements of Contract Documents and reviewed submittals.
- B. Quantities are correct.
- C. Accessories and installation hardware are correct and complete.
- D. Containers and packages are intact and labels legible.
- E. Products are protected and undamaged.

3.2.6 Damages or nonconforming items shall be removed immediately to a separate storage area for removal from the site.

3.3 PRODUCT HANDLING

3.3.1 Provide equipment and personnel to handle products by methods to prevent soiling and damage.

3.3.2 Provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

3.3.3 Handle product by methods to avoid bending or overstressing. Lift large and heavy components only at designated lift points.

3.4 STORAGE AND PROTECTION

3.4.1 Store products, immediately on delivery, in accordance with Manufacturer's instructions, with seals and labels intact. Protect until installed.

3.4.2 Arrange storage in a manner to provide access for maintenance of stored items and for inspection.

3.5 ENCLOSED STORAGE

3.5.1 Store those products subject to damage by the elements in substantial, weathertight enclosures.



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SPECIFICATION FOR MATERIAL AND EQUIPMENT			
<p>3.0 EXECUTION (continued)</p> <p>3.5.2 Maintain temperature and humidity within ranges stated in Manufacturer's instructions.</p> <p>3.5.3 Provide ventilation for sensitive products as required by Manufacturer's instructions.</p> <p>3.5.4 Store unpacked and loose products on shelves, in bins, or in neat groups of like items.</p> <p>3.6 EXTERIOR STORAGE</p> <p>3.6.1 Provide substantial platforms, blocking or skids to support fabricated products above ground slope to provide drainage. Protect products from soiling and staining.</p> <p>3.6.2 For products subject to discoloration or deterioration from exposure to the elements, cover with impervious sheet material. Provide ventilation to avoid condensation.</p> <p>3.6.3 Store loose granular materials on clean, solid surfaces such as pavement, or on rigid sheet materials. Prevent mixing with foreign matter.</p> <p>3.6.4 Provide surface drainage to prevent erosion and ponding of water.</p> <p>3.6.5 Prevent mixing of refuse or chemically injurious materials or liquids.</p> <p>3.7 MAINTENANCE OF STORAGE</p> <p>3.7.1 Periodically inspect stored products on a scheduled basis.</p> <p>3.7.2 Verify that storage facilities comply with Manufacturer's product storage requirements.</p> <p>3.7.3 Verify that Manufacturer-required environmental conditions are maintained continuously.</p> <p>3.7.4 Verify that surfaces of products exposed to the elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents.</p>			



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SPECIFICATION FOR MATERIAL AND EQUIPMENT

3.0 EXECUTION (continued)

3.8 MAINTENANCE OF EQUIPMENT STORAGE

3.8.1 For mechanical and electrical equipment in long-term storage, provide Manufacturer's service instructions to accompany each item, with notice of enclosed instructions shown on exterior of package.

3.8.2 Service equipment on a regularly-scheduled basis, maintaining a log of service; submit as a record document.

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 01700		
			SPECIFICATION FOR CONTRACT CLOSE-OUT		
BY	APPROVED	ISSUE DATE			
BB	<i>GR Thomas</i>	8/19/96			

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					SPECIFICATION FOR CONTRACT CLOSE-OUT	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
BB	<i>gr Thomas</i>	8/19/96	0	8/19/96		

1.0 GENERAL

1.1 DESCRIPTION

The project shall be determined complete in accordance with the acceptance criteria outlined in this section. This section includes descriptions of specific inspection and verification methods that shall be performed prior to the completion of construction. As a minimum, all acceptance and testing requirements described in this section shall be addressed prior to the Contractor's demobilization and final acceptance of the Work by the Owner/Engineer. The Contractor shall maintain and protect the Work in good condition until formal acceptance.

1.2 RELATED SECTIONS

Section 01041 - Project Coordination

Section 01300 - Submittals

Section 01720 - Project Record Documents

1.3 MINIMUM LEVEL OF ACCEPTANCE INSPECTION AND TESTING

1.3.1 Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for final inspection.

1.3.2 The Contractor shall demonstrate to the Owner/Engineer that all equipment and materials are operational and are installed in satisfactory condition. At a minimum the Contractor shall provide for the following inspection and verification:

- A. Verify that all wells, pipelines, equipment and materials are installed in accordance with the Drawings and Specifications.
- B. Verify that all buildings and structure have been properly installed.
- C. Pressure test all piping.
- D. Verify that all mechanical equipment including pumps, motors, valves, etc., function properly.
- E. Verify that all controls are wired properly, wires and controls are labeled and controls function properly.



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SPECIFICATION FOR CONTRACT CLOSE-OUT

1.0 GENERAL (continued)

F. Verify the successful operation of the system.

G. Verify that cleanup has been performed satisfactorily.

H. Verify locations and grades of all items and components have been installed in accordance with the Contract documents.

I. Verify that all painting and tank lining is complete and has been applied in accordance with these Contract documents.

J. Verify that the concrete work is in accordance with these Contract documents.

K. Verify that all products and materials provided for the Work are in accordance with the Contract documents.

L. Verify that all pipes are adequately supported.

M. The Contractor shall submit all necessary and completed records Drawings and manuals containing manufacturer's equipment operating instructions and warranties for all equipment furnished by the Contractor, to the Owner/Engineer, and in accordance with these Contract documents.

1.4 MANUFACTURER'S EQUIPMENT OPERATING INSTRUCTIONS

1.4.1 Contractor shall submit a final Manufacturers' Equipment Operating Instruction Manual in accordance with Section 01300, Submittals.

1.4.2 The final Manufacturers' Equipment Operating Instruction Manual shall be submitted to the Owner/Engineer by the Contractor prior to request for final payment.

2.0 PRODUCTS

(Not used.)

3.0 EXECUTION

A final walk-through will be conducted by the Owner/Engineer, and Contractor to verify that all Work is complete, and that it has been performed in accordance with all Contract Documents. All deficiencies shall be completed and all defects shall be repaired to the satisfaction of the Owner/Engineer, before the project will not be considered complete.

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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K-784-00

SPECIFICATION FOR PROJECT RECORD DOCUMENTS

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BB	<i>JP Thomas</i>	8/19/96	0	8/19/96		

1.0 GENERAL

1.1 DESCRIPTION

The Contractor shall maintain records at the site for the Owner/Engineer. The records shall consist of, but not be limited, to one copy of:

- A. Contract and Record Drawings
- B. Specifications
- C. Addenda
- D. Design Changes, Clarifications, Change Orders and other modifications of the Contract
- E. Owner/Engineer field orders or written instructions
- F. Field test records
- G. Construction photographs
- H. Record mylars of submittals
- I. Health and Safety Plan
- J. Quality Control Plan
- K. Spill Control and Contingency Plan
- L. Sampling and Analysis Plan
- M. Work Plan
- N. Contractor Certificate
- O. Deficiency Reports
- P. Contractor Daily Progress Reports
- Q. Inspection and Test Reports
- R. Well Boring Logs and Reports



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SPECIFICATION FOR PROJECT RECORD DOCUMENTS			
<p>1.0 GENERAL (continued)</p> <p>S. Submittals and Submittal Register</p> <p>T. Laboratory Analytical Data</p> <p>U. Environmental Protection Plan</p> <p>1.2 RELATED SECTIONS</p> <p>Section 01300 - Submittals</p> <p>Section 01700 - Project Close-out</p> <p>1.3 MAINTENANCE OF DOCUMENTS</p> <p>1.3.1 Store documents in Contractor's field office, apart from documents used for construction.</p> <p>1.3.2 Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.</p> <p>1.3.3 Make documents available at all times for inspection by Owner/Engineer.</p> <p>1.4 RECORD DRAWINGS</p> <p>1.4.1 The Contractor shall provide and maintain a complete and accurate set of record Drawings and a record set of Specifications. Submit to the Owner/Engineer one set of record Drawings and Specifications for back checking within 15 working days of the final inspections.</p> <p>1.4.2 The Contractor shall indicate clearly and correctly all Work installed differently from that shown and shall keep records up-to-date as Work progresses. Contractor shall indicate finish grade or flow line elevations accurately dimensioned from the base line.</p> <p>1.4.3 Upon completion of the Work and before application for final payment is made, the Contractor shall furnish to the Owner/Engineer a complete set of record Drawings. Such Drawings shall be acceptable to and approved by the Owner/Engineer before final payment is made to the Contractor. Record Drawings shall be on reproducible tracings supplied by the Owner/Engineer. One set of prints shall accompany reproducible and shall be paid for by the Contractor. Quality of Drawings shall equal original Drawings.</p>			



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SPECIFICATION FOR PROJECT RECORD DOCUMENTS

1.0 GENERAL (continued)

1.5 RECORDING

A. Label each document "Project Record" in neat, large printed letters.

B. Record information concurrently with construction progress.

- Do not conceal any Work until required information is recorded.

C. Legibly mark Drawings to record actual construction:

- Field changes of dimension and detail.
- Changes made by field order or by change order.
- Details not on original Contract Drawings.

D. Legibly mark each Section of the Specifications and Addenda to record:

- Changes made by field order or by change order.

1.6 SUBMITTAL

A. In accordance with Section 01300, Submittals.

B. At Contractor close-out, submit record documents and one set of blue-line prints to Owner/Engineer. Blue-line prints shall be made by Contractor after Owner/Engineer has received record drawings.

C. Accompany submittal with transmittal letter, in triplicate, containing:

- Date
- Project title and number
- Contractor's name and address
- Title and number of each record document
- Signature of Contractor or Contractor's authorized representative.



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SPECIFICATION FOR PROJECT RECORD DOCUMENTS

2.0 PRODUCTS

(Not Used.)

3.0 EXECUTION

(Not Used.)

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DIVISION 2



Jacobs Engineering Group, Inc.
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AFCEE MMR - PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 02010		
			SPECIFICATION FOR GEOTECHNICAL ENGINEERING SERVICES		
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JEG JOB NO. 35-K-784-00						
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1.0 **GENERAL**

1.1 **DESCRIPTION**

These specifications outline the work required for a geological investigation and report. The work shall include field and lab work, engineering evaluation and establishment of the design criteria for the foundations and civil engineering phase of the MMR-Plume Response Projects, Otis ANGB, MA.

1.2 **DEFINITIONS**

A. "Owner" shall mean AFCEE.

B. "Civil Engineer" shall mean Owner's Principal Civil Engineer or designated representative.

C. "Site Manager" shall mean Owner's Manager of Construction or designated site manager, resident construction engineer or representative.

D. "Contract Documents" shall mean Owner's drawings, these specifications, insurance requirements, "Contractor's Procedure and Safety Manual for Working Within the Existing Facility," and the subcontract order, including all attachments or modifications thereto. In the event any discrepancy among the contract documents should occur, the discrepancy shall be referred to the Site Manager for clarification.

E. "Soils Consultant" shall mean the individual, firm or corporation who shall make the borings, obtain soil samples, perform field work (whether subcontracted or not), perform laboratory testing, analyze data and laboratory tests, establish recommendations, prepare and submit soils report of work, and provide all services adjunct thereto.

F. "Reports(s)" shall mean the final soil report and interim reports submitted by the Soils Consultant, with all required inclusions. All reports and recommendations shall be prepared under the direction of a Registered Professional Engineer licensed in the Commonwealth of Massachusetts and shall bear seal and signature attesting to the correctness of the Report and/or recommendations.



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**SPECIFICATION
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1.0 **GENERAL** (continued)

G. "Work" shall mean all services to be performed under these Contract Documents and shall include all necessary labor, materials, equipment and services.

1.3 **QUALITY ASSURANCE**

A. All field services shall be performed by qualified personnel familiar with construction safety rules and these Contract Documents.

B. All methods, techniques and procedures used in the field and/or laboratory shall comply with the requirements of American Society for Testing and Materials (hereinafter called "ASTM").

C. All field services shall be performed by qualified personnel, familiar with and experienced in the methods, techniques, procedures, and equipment.

D. All laboratory testing shall be performed by qualified personnel, familiar with and having access to equipment and facilities for the accurate determination of the data necessary for the requirements of these specifications.

E. Interpretation of any and all testing and data, in addition to the preparation of the report, shall be by a licensed professional engineer. The report shall be signed and sealed by the professional engineer responsible for the contents of the report.

1.4 **SUBMITTALS**

A. Schedule to complete the work. The stated length of time shall be from mobilization to completion of final formal report by the Soils Consultant.

B. Soils Consultant shall submit the following to the Owner before any work begins:

1. Name and Qualifications of Personnel Assigned to Work
2. List of Services Available
3. Program for Work per Contract Documents
4. Schedule of Work
5. Unit Rate Fees
6. Signed Insurance Agreement



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SPECIFICATION FOR GEOTECHNICAL ENGINEERING SERVICES			
1.0	GENERAL (continued)		
	C. The Subcontractor will submit written reports (original plus 3 copies) within three (3) days of testing.		
1.5	JOB CONDITIONS		
	A. The Soils Consultant shall meet with Owner's Site Manager, visit and inspect the site before proceeding with any work so as to become fully aware of all field conditions.		
	B. Soils Consultant shall coordinate all field work with Owner's Site Manager.		
2.0	PROJECT DESCRIPTION		
2.1	TREATMENT UNIT BUILDING		
	A. Pre-engineering building 108' x 153'. Column spacing at 30'-0", eaves height 30'-0".		
	B. Equipments inside the building are supported on separate spread footings. Major equipments include:		
	1. Influent Holding Tank	14'φ x 20'	
	2. Effluent Holding Tank	14'φ x 20'	
	3. Sedimentation Tank	14'φ x 20'	
	4. Carbon Filters	10'φ x 14'	
	5. Greensand Filters	10'φ x 6'	
	6. Air compressor and pumps		
	C. Concrete floor slab on grade with a system of trenches and sumps to collect waste materials. Floor slab shall be designed for 150 psf live load or 5000 lbs. forklift operating or H-20 loading.		
	Soil report shall provide subgrade modulus (pci) and recommend the slab thickness for different loading conditions.		
	D. Paving around building for H-20 loading and parking space. Wearing surface of paving will be asphaltic concrete or gravel.		



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2.0 PROJECT DESCRIPTION (continued)			
Soil report shall recommend the thickness and type of materials (i.e., wearing course, base course and sub-base) for different loading conditions and different wearing surfaces.			
2.2 Well Site			
A. MCC pre-fabrication building 10' x 12' house transformer and electrical panels.			
B. Extraction/injection wells with 6' x 6' x 6' deep reinforced concrete vaults. Bottom of vault is approximately 6' below existing grade.			
C. Roadway from main road to well site and around the well site.			
Wearing surface of roadway will be gravel. Soil report shall recommend thickness and type of materials (i.e. wearing course, base course, sub-base) for different loading conditions.			
2.3 PIPE LINE			
Underground double-wall and single-wall pipes running from well site to treatment unit and vise versa. Top of pipe is at least 4'-0" below existing grade.			
3.0 EXECUTION			
3.1 FIELD WORK			
A. Surveying work.			
1. Locate and properly mark borings.			
2. Determine and mark grade elevations relative to plant elevations of each boring.			
B. Method of Boring			
1. Borings carried to a minimum depth of 25 feet or practical refusal.			
2. Indicate dates of boring: Start and Finish.			



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3.0 <u>EXECUTION</u> (continued)			
C. Sampling			
1. Undisturbed			
a) Obtain at 5, 10, 15, 25 ft. depth.			
b) Use thin-walled tube (see ASTM D 2587).			
c) Seal and cap ends of tube prior to shipment.			
d) Prevent drying and/or disturbance of sample.			
2. Disturbed			
a) Obtain specimens of each soil stratum encountered as directed by Soils Consultant.			
b) Use air-tight containers.			
c) Use split-barrel sampler (see ASTM D 1586).			
3. Identify all samples by boring numbers, description of sample, elevation obtained, blow-count number and date.			
4. Recovery Ratio: Keep record of sampling recovery ratio.			
D. Standard Penetration Test or Penetrometer Testing			
1. Per ASTM D 1586.			
2. In all soil strata.			
3. Interval: Minimum 5 foot increments.			
E. Ground Water			
1. Determine ground water levels, initially and 24 hours later.			
2. Conduct water in flow tests.			
3. Obtain a sufficient number of ground water samples for lab testing at locations indicated on Contract Drawings.			



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SPECIFICATION FOR GEOTECHNICAL ENGINEERING SERVICES			
<p>3.0 <u>EXECUTION</u> (continued)</p> <p>F. Field Services</p> <ol style="list-style-type: none">1. Soils technician to determine in-place density (ASTM 2922) of compacted fill materials in accordance with contract specifications and immediately report results to the Jacobs Site Manager.2. Sampling technician to sample cast-in place concrete. <p>3.2 LABORATORY WORK</p> <p>A. Ground Water Analysis: Determine the degree or concentrations of the following for purposes of determining effects on design and construction.</p> <ol style="list-style-type: none">1. pH2. Alkalinity3. Sulfate4. Chlorides <p>B. Index Properties for Soil Classification</p> <ol style="list-style-type: none">1. Grain size analysis2. Atterberg limits3. Specific gravity4. Moisture content <p>C. Disturbed Samples Testing</p> <ol style="list-style-type: none">1. CBR values at loading areas and soil modulus of elasticity for slab design.2. Compaction-density relationships. <p>D. Engineering Properties</p> <ol style="list-style-type: none">1. Shearing Strength2. Consolidation/Compressibility			



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SPECIFICATION FOR GEOTECHNICAL ENGINEERING SERVICES			
<p>3.0 <u>EXECUTION</u> (continued)</p> <ul style="list-style-type: none">3. Permeability4. Cohesion5. Shrinkage and Swell <p>E. Laboratory Services</p> <ul style="list-style-type: none">1. Washed sieve analysis2. Proctor density <p>3.3 REPORT FORMAT</p> <p>The Formal Report shall clearly and definitively state the geotechnical design criteria and recommendations based upon the accumulated data required under these specifications. The report shall encompass practical considerations with emphasis on economy and timing of construction. The report shall include, but not be limited to, the following items.</p> <ul style="list-style-type: none">A. Boring Logs.B. Results of all Field and Laboratory Tests.C. Chart of ASTM Soil Classification System.D. Geological and Historical Data (brief, not extensive)E. Observations based on past experience of similar soil conditionsF. Complete set of recommendations as required for development of the site and design/construction.<ul style="list-style-type: none">1. Types of foundations to be used (spread footing, drilled shafts, etc.).2. Net allowable soil pressures for various foundation sizes and factor of safety.3. Foundation bearing elevation (min. foundation depths).4. Amount of settling expected (load-settlement curve).			



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<p>3.0 <u>EXECUTION</u> (continued)</p> <p>5. Ground water table elevations.</p> <p>6. Construction practices recommendations:</p> <ul style="list-style-type: none">a) Dewateringb) Excavatingc) Backfilling, compacting, and filling <p>7. Recommendation for roadway design (wearing surfaces base and sub-base) for different loading conditions..</p> <p>8. Suitability of existing soil for embankment construction and backfilling.</p> <p>9. Electrical resistivity of the soil (ohms/cm).</p> <p>10. Recommended lateral pressure to be used in the design of retaining walls and thrust blocks (active and passive)</p> <p>11. Coefficient of friction between concrete and soil</p> <p>12. Earthwork recommendation regarding fill types, compaction criteria and embankment side slopes.</p> <p>13. Comments on the chemical nature of the soil and ground water with regard to potential deleterious effects on concrete.</p> <p>14. Any additional information that the Soils Consultant deems necessary which will be an aid in the understanding of the recommendations, be helpful in the design of foundations, or facilitate construction, shall be included in the Report.</p> <p>3.4 GENERAL SERVICES</p> <p>A. Submit a price for the following items</p> <ul style="list-style-type: none">1. Field technician - rate per hour2. Sieve analysis - each3. Travel time - labor costs and/or per diem (if any)4. Minimum time charge			



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**SPECIFICATION
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ENGINEERING SERVICES**

3.0 **EXECUTION** (continued)

5. Equipment costs - rate per item (if not included in other unit rates)

6. Proctor density - each

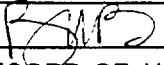

7. Concrete cylinder compression test: \$_____ per set. Set equals 3 cylinders; 7 day break ; 28 day break; and hold cylinder. These costs do not include breaking the "hold" cylinder.

8. Break "hold" cylinder: \$_____ each. (Upon request and approval of JEG only).



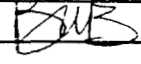
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Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00				NO. 02110	
				SPECIFICATION FOR SITE CLEARING	
BY MHH	APPROVED 	ISSUE DATE 8/23/96			
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					SPECIFICATION FOR SITE CLEARING	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
MHH		8/23/96	0	8/23/96		

1.0 **GENERAL**

1.1 **Section Included**

- A. Remove surface debris.
- B. Remove paving, curbs.
- C. Clear site of plant life and grass.
- D. Remove trees and shrubs.
- E. Remove root system of trees and shrubs.

1.2 **Related Sections**

- A. Section 02220, Structure Excavation and Backfilling

1.3 **Regulatory Requirements**

- A. Conform to applicable Federal, State, and Local codes for disposal of debris.
- B. Coordinate clearing work with utility companies.

2.0 **PRODUCTS**

Not used.

3.0 **EXECUTION**

3.1 **Preparation**

- A. Verify that existing plant life and features designated to remain are tagged or identified.

3.2 **Protection**

- A. Protect utilities that remains, from damage.
- B. Protect trees, plant growth, and features designated to remain as final landscaping.



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SPECIFICATION FOR SITE CLEARING

3.0 EXECUTION (continued)

- C. Protect bench marks and existing structures from damage or displacement.

3.3 Clearing

- A. Clear areas required for access to site and execution of work.
- B. Remove paving and curbs as shown on the drawings.
- C. Remove trees and shrubs within marked areas. Remove stumps, root system to a depth of 18 inches or as otherwise shown on the drawings.
- D. Clear undergrowth and deadwood.
- E. Apply herbicide to remaining stumps to inhibit growth.

3.4 Removal

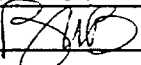
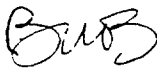
- A. Remove debris, rock, and extracted plant life from site.

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BY		APPROVED		ISSUE DATE	
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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING					
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1.0 **GENERAL**

1.1 **Section Includes**

- A. Excavation for building foundations.
- B. Excavation for slabs-on-grade and paving.
- C. Excavation for site structures.
- D. Building perimeter and site structure backfilling to subgrade elevations.
- E. Site filling and backfilling.
- F. Fill under slabs-on-grade and paving. Consolidation and compaction.
- G. Fill for over-excavation.

1.2 **Related Sections**

- A. Section 03300 Cast-in-Place Concrete
- B. Section 02831 Chain Link Fence

1.3 **Reference Standards** (Latest Edition)

- A. ASTM D422: Particle Size Analysis of Soils
- B. ASTM D424: Test for Plastic Limit and Plasticity Index of Soils
- C. ASTM D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³ (600kN-m/m³))
- D. ASTM D1556: Test Method for Density of Soil In-Place by the Sand-Cone Method
- E. ASTM D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³ (2,700kN-m/m³))



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

1.0 GENERAL (continued)

- F. ASTM D2167: Test for Density of Soil In-Place by the Rubber-Balloon Method
- G. ASTM D2487: Classification of Soils for Engineering Purposes
- H. ASTM D2922: Test for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
- I. ASTM D4253: Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- J. ASTM D4254: Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.4 Submittals

A. Dewatering

Submit proposed methods and details for dewatering procedures to the Engineer for approval before beginning excavation operations.

B. Samples

Submit representative samples of borrow soils.

C. Test Results

1. Contractor shall be responsible for the testing of representative samples of borrow that the Contractor intends to use as fill or backfill.
2. Tests shall consist of:
 - a. Gradation
 - b. Relative Density of Cohesionless Soils
 - c. Moisture Density Curves per ASTM D698
 - d. Soil Classification



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

1.0 **GENERAL** (continued)

3. All data to be submitted for approval.

D. **Source**

Submit source of supply for all material used in filling and backfilling for approval.

E. **Field Density Tests**

Field density test results shall be verbally reported to the Engineer as soon as they are available. Subsequent to verbal notification, formal documentation of the results shall be submitted to the Engineer.

2.0 **PRODUCTS**

2.1 **Materials**

A. **Suitable Borrow Material**

1. Suitable borrow materials shall include material classified using the Unified Soil Classification System as GW, GP, SW, SP, GM, GC, SM, SC, CL, CH, or as approved by the Engineer as per ASTM D422, D424 and D2487.

2. Suitable borrow material shall be chemically uncontaminated and free from debris, organic material, large stones and excess moisture that will prevent proper compaction.

3. Obtain suitable borrow material from either onsite or offsite sources.

B. **Select Borrow Material**

1. Select borrow material shall be soils of low expansion potential having a liquid limit of less than 40 and plasticity index below 15, as tested in accordance with ASTM D424. At least 12% of the material should pass a No. 200 sieve.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

2.0 PRODUCTS (continued)

2. Select borrow material shall be chemically uncontaminated and free from debris, organic material, large stones and excess moisture that will prevent proper compaction.
3. Obtain select borrow material from either onsite or offsite sources.

C. Unsuitable Material

1. Unsatisfactory materials include materials classified using the Unified Soil Classification System as PT, OH, OL and materials of any classification that are determined by the Engineer as too wet for use in the backfilling operations.
2. Salt, sulfur, hydrocarbon or other chemically impregnated soils shall be considered unsuitable for reuse.

D. Borrow Clay

1. Suitable borrow clay shall include material classified using the Unified Soil Classification System as CL, CH or any mixture of these per ASTM D422, D424 and D2487.
2. Suitable borrow clay shall be chemically uncontaminated and free from debris, organic material, large stones and excess moisture that will prevent proper compaction.

E. Borrow Sand

1. Borrow sand for sandfill and backfill shall be sound, hard, durable, angular material meeting the following gradation requirements:

SIEVE (U. S. Standard)	PERCENT PASSING (by Weight)
3/8"	100
#4	95-100
#40	12-60
#200	0-12



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING**2.0 PRODUCTS (continued)****F. Borrow Stone**

Backfill around foundations should consist of clean 3/4-minus stone or well graded sand and gravel free of organic material, trash, ice, frozen soil, and other deleterious materials. The recommended gradation for granular fill should satisfy the following limits.

SIEVE (U. S. Standard)	PERCENT FINER by WEIGHT (by Weight)	
	<u>Min.</u>	<u>Max.</u>
4"	100	---
2"	65	100
#4	30	80
#20	10	65
#40	5	40
#100	0	20
#200	0	8

3.0 EXECUTION**3.1 Preparation**

- A. Identify required lines, levels, contours and datum.
- B. Identify known underground, above ground and aerial utilities. Stake and flag locations.
- C. Notify utility company to remove and relocate utilities.
- D. Protect above and below grade utilities which are to remain.
- E. Protect plant life, lawns and other features remaining as a portion of final landscaping.
- F. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavation equipment and vehicular traffic.
- G. Generally, compact subgrade to density requirements for subsequent backfill materials.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

- H. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with fill and compact to density equal to or greater than requirements for subsequent backfill materials.
- I. Prior to placement of aggregate base course material at paved areas, compact subsoil to 95 percent of its maximum dry density in accordance with ASTM D698.

3.2 Examination

- A. Verify fill materials to be reused are acceptable.
- B. Verify foundation perimeter drainage installation has been inspected.

3.3 Excavation

- A. All excavations shall be protected and guarded against danger to life and property and shall conform to OSHA "Construction Standard for Excavations" (29 CFR Part 1926.650-.652, Subpart P). Permanent excavations or fill shall have retaining walls sufficient in strength to retain the embankment, together with any surcharge loads, unless the sides slope sufficiently for this retention.
- B. Excavate subsoil required to accommodate building foundations, paving and site structures and construction operations.
- C. Excavate to working elevation(s). Coordinate special requirements for piling.
- D. Machine slope banks to angle of repose or less, until shored.
- E. Excavation cut not to interfere with normal 45° bearing splay of foundation.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

- F. Grade top perimeter of excavation to prevent surface water from draining into excavation. Any water that does accumulate in an excavation during working hours shall be removed continuously or as a significant accumulation occurs. Overnight accumulation shall be removed immediately at the beginning of the work day. The Contractor shall provide temporary pumping facilities to drain the water to the nearest catch basin or drainage ditch.
- G. Hand trim excavation. Remove loose matter.
- H. Remove lumped subsoil, boulders and rock.
- I. Hand excavation shall be required around any below grade piping or other utilities. Support piping and other utilities which could be damaged by excavation work. Any piping or pipe coating that is damaged shall be repaired at the Contractor's expense.
- J. If underground obstructions, piping or other utility services are encountered which are not indicated on the drawings or in the specifications, instructions shall be obtained from the Engineer before proceeding.
- K. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- L. Correct unauthorized excavation at no extra cost to Owner.
- M. Correct areas over-excavated by error by placing lean concrete in the excavation to the correct elevation.
- N. Stockpile excavated material in area designated onsite and remove excess material not being reused from site.

3.4 Backfilling

- A. Backfill areas to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 EXECUTION (continued)

C. Granular Soils Fill

Place and compact materials in continuous layers not exceeding six inches compacted depth.

D. Compact granular backfill that is insensitive to compaction moisture to an in-place density of at least 70 percent relative density, as defined in ASTM D4253 and ASTM D4254.

E. Cohesive Soils Fill

Place and compact material in continuous layers not exceeding 8 inches compacted depth.

F. Clayey sands and cohesive soils that are sensitive to compaction moisture shall be placed and compacted to at least 95 percent of the Standard Proctor maximum density determined in accordance with Method A of ASTM D698. Moisture content of the fill shall be controlled within ± 2 percent of optimum moisture.

G. Upon placement and compaction of each lift of cohesive material, the surface shall be scarified to a depth of two inches prior to the placement of subsequent lift.

H. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation waterproofing and protective cover utilities in trenches.

I. Maintain optimum moisture content of backfill materials to attain required compaction density.

J. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.

K. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.



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SPECIFICATION FOR STRUCTURE EXCAVATION AND BACKFILLING

3.0 **EXECUTION** (continued)

 L. Slope grade away from building minimum two inches in 10 feet, unless noted otherwise.

 M. Make grade changes gradual. Blend slope into level areas.

 N. Remove surplus backfill materials from site.

 O. Leave fill material stockpile areas completely free of excess fill materials.

3.5 **Tolerances**

 A. Top Surface of Backfilling

 Plus or minus one inch from required elevations.

3.6 **Field Quality Control**

 A. The Contractor shall conduct field density tests during backfill and fill placement. The tests shall be performed by qualified Soil Technicians working under the direction of a Soils Engineer registered in the state where the project is located.

 B. Field density tests shall be performed in accordance with ASTM D2922, D1556 or D2167.

 C. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.

 D. Frequency of Tests

 1. Every 50 cubic yards of fill or backfill in trenches or around structures.

 2. Every 200 cubic yards for embankment, dike or other mass earthwork.

 3. At least one test shall be made for every full day of compaction operations on mass earthwork.



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3.0 EXECUTION (continued)

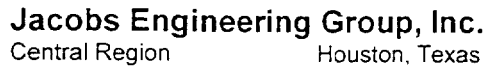
4. One test whenever there is a definite change in the quality of moisture control or effectiveness of compaction.

- E. Proof roll compacted fill surfaces under slabs-on-grade paving.

3.7 Protection of Finished Work

- A. Recompact fills subjected to vehicular traffic.
- B. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.
- C. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K784-00

SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

9/3/96

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1.0 **GENERAL**

1.1 **Section Includes**

- A. Excavate trenches for underground pipe, culverts and electrical utilities.
- B. Compacted bedding below pipe, culverts and electrical utilities.
- C. Backfilling and compaction to subgrade elevations.

1.2 **Related Sections**

- A. Section 03300 Cast-in-Place Concrete

1.3 **Reference Standards** (Latest Edition)

- A. ASTM D422: Particle Size Analysis of Soils
- B. ASTM D424: Test for Plastic Limit and Plasticity Index of Soils
- C. ASTM D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³ (600kN-m/m³))
- D. ASTM D1556: Test Method for Density of Soil In-Place by the Sand-Cone Method
- E. ASTM D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³ (2,700kN-m/m³))
- F. ASTM D2167: Test for Density of Soil In-Place by the Rubber-Balloon Method
- G. ASTM D2487: Classification of Soils for Engineering Purposes
- H. ASTM D2922: Test for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

1.0 GENERAL (continued)

- I. ASTM D4253: Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- J. ASTM D4254: Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.4 Submittals

A. Dewatering

Submit proposed methods and details for dewatering procedures to the Engineer for approval before beginning excavation operations.

B. Samples

Submit representative samples of borrow soils.

C. Test Results

1. Contractor shall be responsible for the testing of representative samples of borrow that the Contractor intends to use as fill or backfill.
2. Tests shall consist of:
 - a. Gradation
 - b. Relative Density of Cohesionless Soils
 - c. Moisture Density Curves per ASTM D698
 - d. Soil Classification
3. All data to be submitted for approval.

D. Source

Submit source of supply for all material used in filling and backfilling for approval.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

1.0 **GENERAL** (continued)

E. **Field Density Tests**

Field density test results shall be verbally reported to the Engineer as soon as they are available. Subsequent to verbal notification, formal documentation of the results shall be submitted to the Engineer.

2.0 **PRODUCTS**

2.1 **Materials**

A. **Suitable Borrow Material**

- Suitable borrow materials shall include material classified using the Unified Soil Classification System as GW, GP, SW, SP, GM, GC, SM, SC, CL, CH, or as approved by the Engineer as per ASTM D422, D424 and D2487.
- Suitable borrow material shall be chemically uncontaminated and free from debris, organic material, large stones and excess moisture that will prevent proper compaction.
- Obtain suitable borrow material from either onsite or offsite sources.

B. **Unsuitable Materials**

- Unsatisfactory materials include materials classified using the Unified Soil Classification System as PT, OH, OL and materials of any classification that are determined by the Engineer as too wet for use in the backfilling operations.
- Salt, sulphur and hydrocarbon or other chemically impregnated soils shall be considered unsuitable for reuse.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

2.0 PRODUCTS (continued)

C. Borrow Sand

1. Borrow sand for pipe and electrical conduit and cable bedding shall be sound, hard, durable, angular materials meeting the following gradation requirements

SIEVE (U. S. Standard)	PERCENT PASSING (by Weight)
3/8"	100
#4	95-100
#40	12-60
#200	0-12

3.0 EXECUTION

3.1 Examination

- A. Verify fill materials to be reused are acceptable.

3.2 Preparation

- A. Identify required lines, levels, contours and datum.
- B. Prior to excavating or trenching operation, location of all existing underground installations shall be verified.
- C. Any damage to underground installations shall be repaired, including but not limited to repairing doped and wrapped piling.
- D. Protect plant life, lawns, rock outcropping and other features remaining as a portion of final landscaping.
- E. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavation equipment and vehicular traffic.
- F. Protect above and below grade utilities which are to remain.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

3.0 EXECUTION (continued)

- G. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with suitable fill and compact to density equal to or greater than requirements for subsequent backfill materials.

3.3 Excavation

- A. All excavations shall be protected and guarded against danger to life and property and shall conform to OSHA "Construction Standard for Excavations" (29 CFR Part 1926.650-.652, Subpart P). Permanent excavations or fill shall have retaining walls sufficient in strength to retain the embankment, together with any surcharge loads, unless the sides slope sufficiently for this retention.
- B. Excavate subsoil required for pipeline installation
- C. Cut trenches sufficiently wide to enable installation of utilities and allow inspection.
- D. Excavation shall not interfere with normal 45 degree bearing splay of existing foundations.
- E. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- F. The bottom of all excavations shall be properly leveled and all loose material shall be removed or compacted before placing concrete or installing pipe. Excavations shall be kept free of water and debris until the underground piping installation has been tested.
- G. Correct unauthorized excavation at no cost to Owner. •
- H. Correct areas over-excavated by error by placing lean concrete in the excavation to the correct elevation.

3.4 Bedding

- A. Bedding shall conform to one of the classes below. If no class is specified on the drawing, then Class "C" bedding shall be used.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

3.0 EXECUTION (continued)

1. Class A - Concrete Cradle Bedding - requires embedment of the lower part of the pipe in plain or reinforced concrete of suitable thickness and extending up to the sides of the pipe a distance not less than 25% of the depth of the pipe.
 2. Class B - First Class Bedding - requires the pipe to be placed on the fine granular materials foundation extending up to the center line of the pipe. The trench is then filled to 1 ft. over the top of the pipe with granular material in 6 inch layers and compacted to fill all the space around the pipe.
 3. Class C - Ordinary Bedding - requires placing the pipe on fine granular material cradle extending up to the sides of the pipe a distance not less than 1/6 the depth of the pipe. The trench is then filled to 6 inches over the top of the pipe with granular material placed and compacted to fill all space around the pipe.
 4. Class D - Impermissible Bedding - allows the pipe to be placed on the bottom of the trench with no effort to shape the trench to fit the pipe. Fill is placed around the pipe.
- B. The American Concrete Pipe Association recommends two types of bedding for precast box culverts in trenches.
1. Class B Bedding is obtained by installing the box section on a minimum thickness of fine granular material at least 2 inches thick. Compacted granular material is placed on each side of the box section and up to at least 1 ft. over the top of the box.
 2. Class C Bedding is obtained by placing the box section on a flat trench bottom. Lightly compacted fill is placed on each side of the box section and up to 6 inches over the top of the box.
- C. Conduits shall be placed a minimum of 2' - 0" below grade, and backfill placed and compacted to fill all space around conduits.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

3.0 EXECUTION (continued)

3.5 Backfilling

- A. Backfill shall proceed as soon as possible after the installed pipe system has been tested, inspected and accepted.
- B. Backfill trencher to contours and elevations with unfrozen materials.
- C. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- D. Granular Soils Fill

Place and compact materials in continuous layers not exceeding six inches compacted depth.
- E. Compact granular backfill that is insensitive to compaction moisture to an in-place density of at least 70 percent relative density, as defined in ASTM D4253 and ASTM D4254.
- F. Cohesive Soils Fill

Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- G. Clay sands and cohesive soils that are sensitive to compaction moisture shall be placed and compacted to at least 95 percent of the Standard Proctor maximum density determined in accordance with Method A of ASTM D698. Moisture content of the fill shall be controlled within ± 2 percent of optimum moisture.
- H. Upon placement and compaction of each lift of cohesive material, the surface shall be scarified to a depth of two inches prior to the placement of subsequent lift.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

3.0 EXECUTION (continued)

- I. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation waterproofing and protective cover utilities in trenches.
- J. Maintain optimum moisture content of backfill materials to attain required compaction density.
- K. Remove surplus backfill materials from site.
- L. Leave fill material stockpile areas completely free of excess fill materials.

3.6 Tolerances

- A. Top Surface of Backfilling
Plus or minus one inch from required elevations.
- B. Top Surface of General Backfilling
Plus or minus one inch from required elevations.

3.7 Field Quality Control

- A. The Contractor shall conduct field density tests during backfill and fill placement. The tests shall be performed by qualified Soil Technicians working under the direction of a Soils Engineer registered in the state where the project is located.
- B. Field density tests shall be performed in accordance with ASTM D2922, D1556 or D2167.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.
- D. Frequency of Tests
 - 1. Every 50 cubic yards of fill or backfill in trenches or around structures.



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SPECIFICATION FOR TRENCHING, BACKFILLING AND COMPACTION

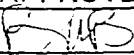

3.0 EXECUTION (continued)

3.8 Protection of Finished Work

- A. Recompact fills subjected to vehicular traffic.
- B. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00				NO. 02230	
				SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING AND COMPACTION	
BY	APPROVED	ISSUE DATE			
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1.0 GENERAL

1.1 Description

This section describes the requirements for construction of access roads.

Section Includes

- A. Excavation and Disposal of all Materials
- B. Roadway Embankment Construction
- C. Roadway Surface Layer Construction
- D. Roadway Base and Sub-Base Construction

1.2 Related Sections

- A. Section 02110 Site Clearing
- B. Section 02510 Asphaltic Concrete Paving

1.3 Reference Standards (Latest Edition)

- A. ASTM D422: Particle Size Analysis of Soils
- B. ASTM D424: Test for Plastic Limit and Plasticity Index of Soils
- C. ASTM D698: Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³ (600kN-m/m³))
- D. ASTM D1556: Density of Soil In-Place by the Sand-Cone Method
- E. ASTM D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³ (2700kN-m/m³))



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

1.0 GENERAL (continued)

- F. ASTM D2167: Test Density of Soil In-Place by the Rubber-Balloon Method
- G. ASTM D2487: Classification of Soils for Engineering Purposes
- H. ASTM D2922: Tests for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
- I. ASTM D4253: Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- J. ASTM D4254: Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

1.4 Submittals

A. Dewatering

Submit proposed methods and details for dewatering procedures to the Engineer for approval before beginning excavation operations.

B. Samples

Submit representative samples of borrow soils.

C. Test Results

1. Contractor shall be responsible for the testing of representative samples of borrow that the Contractor intends to use as fill or backfill.
2. Tests shall consist of:
 - a. Gradation
 - b. Relative Density of Cohensionless Soils
 - c. Moisture Density Curves per ASTM D698
 - d. Soil Classification
3. All data to be submitted for approval.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

1.0 GENERAL (continued)

D. Source

Submit source of supply for all material used in filling and backfilling for approval.

E. Field Density Tests

Field density test results shall be verbally reported to the Engineer as soon as they are available. Subsequent to verbal notification, formal documentation of the results shall be submitted to the Engineer.

2.0 PRODUCTS

2.1 Materials for Embankment

A. Suitable Borrow Material

1. Suitable borrow materials shall include material classified using the Unified Soil Classification System as GW, GP, SW, SP, GM, GC, SM, SC, CL, CH, or as approved by the Engineer as per ASTM D422, D424, and D2487.
2. Suitable borrow material shall be chemically uncontaminated and free from debris, organic material, large stones and excess moisture that will prevent proper compaction.
3. Obtain suitable borrow material from either onsite or offsite sources.

B. Select Borrow Material

1. Select borrow material shall be soils of low expansion potential having a liquid limit of less than 40 and plasticity index below 15, as tested in accordance with ASTM D424. At least 12% of the material should pass a No. 200 sieve.
2. Select borrow material shall be chemically uncontaminated and free from debris, organic material, large stones and excess moisture that will prevent proper compaction.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

2.0 PRODUCTS (continued)

3. Obtain select borrow material from either onsite or offsite sources.

C. Unsuitable Material

1. Unsatisfactory materials include materials classified using the Unified Soil Classification System as PT, OH, OL and materials of any classification that are determined by the Engineer as too wet for use in the backfilling operations.
2. Salt, sulfur, hydrocarbon or other chemically impregnated soils shall be considered unsuitable for reuse.

D. Borrow Stone and Gravel

1. Borrow stone should consist of clean 3/4-minus stone or well graded sand and gravel free of organic material, trash, ice, frozen soil, and other deleterious materials. The recommended gradation for granular fill should satisfy the following limits.

SIEVE (U. S. Standard)	PERCENT FINER by WEIGHT (by Weight)	
	<u>Min.</u>	<u>Max.</u>
4"	100	—
2"	65	100
#4	30	80
#20	10	65
#40	5	40
#100	0	20
#200	0	8

2.2 Material for Sub-base and Base

A. Borrow Stone or Gravel

The same requirements and gradation for borrow stone or gravel specified for embankment construction.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

2.0 PRODUCTS (continued)

2.3 Material for Wearing Surface

A. Asphalt Concrete

Shall meet the requirements of standard specification 02510.

B. Borrow Stone or Gravel

Shall meet the same requirements of material specified for embankment construction including the binder material.

3.0 EXECUTION

3.1 Preparation

- A. Identify required lines, levels, contours and datum.
- B. Identify known underground, aboveground and aerial utilities. Stake and flag locations.
- C. Notify utility company to remove and relocate utilities.
- D. Protect above and below grade utilities which are to remain.
- E. Protect plant life, lawns and other features remaining as a portion of final landscaping.
- F. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavation equipment and vehicular traffic.
- G. Generally, compact subgrade to density requirements for subsequent backfill materials.
- H. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with fill and compact to density equal to or greater than requirements for subsequent backfill materials.
- I. Prior to placement of aggregate base course material at paved areas, compact subsoil to 95 percent of its maximum dry density in accordance with ASTM D698.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

3.0 EXECUTION (continued)

3.2 Examination

- A. Verify fill materials to be reused are acceptable.
- B. Verify perimeter drainage installation has been inspected.

3.3 Excavation

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Excavate subsoil required to accommodate paving and construction operations.
- C. Machine slope banks to angle of repose or less, until shored.
- D. Excavation cut not to interfere with normal 45° bearing splay of foundation.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Hand trim excavation. Remove loose matter.
- G. Remove lumped subsoil, boulders and rock.
- H. Notify the Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- I. Correct unauthorized excavation at no extra cost to Owner.
- J. Stockpile excavated material in area designated onsite and remove excess material not being reused from site.

3.4 Backfilling

- A. Backfill areas to contours and elevations with unfrozen materials.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

3.0 EXECUTION (continued)

- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Granular Soils Fill

Place and compact materials in continuous layers not exceeding six inches compacted depth.
- D. Compact granular backfill that is insensitive to compaction moisture to an in-place density of at least 70 percent Relative Density, as defined in ASTM D4253 and ASTM D4254.
- E. Cohesive Soils Fill

Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- F. Clayey sands and cohesive soils sensitive to compaction moisture shall be placed and compacted to at least 95 percent of the Standard Proctor maximum density determined in accordance with Method A of ASTM D698. Moisture content of the fill shall be controlled within ± 2 percent of optimum moisture.
- G. Upon placement and compaction of each lift of cohesive material, the surface shall be scarified to a depth of two inches prior to the placement of subsequent lift.
- H. Place asphalt concrete wearing surface as outlined in standard Specification 02510.
- I. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation waterproofing and protective cover utilities in trenches.
- J. Maintain optimum moisture content of backfill materials to attain required compaction density.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

3.0 EXECUTION (continued)

- K. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.
- L. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- M. Maintain surfaces of embankments to drain water at all times.
- N. Completed embankments shall conform to the indicated lines, grades and sections as shown on the drawings.
- O. Remove surplus backfill materials from site.
- P. Leave fill material stockpile areas completely free of excess fill materials.

3.5 Tolerances

A. Top Surface of Backfilling

Plus or minus one inch from required elevations.

3.6 Field Quality Control

- A. The Contractor shall conduct field density tests during backfill and fill placement. The tests shall be performed by qualified Soil Technicians working under the direction of a Soils Engineer registered in the state where the project is located.
- B. Field density test shall be performed in accordance with ASTM D2922, D1556, or D2167.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.
- D. Frequency of Tests
Every 50 cubic yard of fill or backfill.
- E. Proof roll compacted fill surfaces under slabs-on-grade paving.



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SPECIFICATION FOR ROADWAY EXCAVATION, BACKFILLING, AND COMPACTION

3.0 EXECUTION (continued)

3.7 Protection of Finished Work

- A. Recompact fills subjected to vehicular traffic.
- B. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K784-00

NO. 02510

SPECIFICATION
FOR ASPHALT CONCRETE PAVING

BY	APPROVED	ISSUE DATE
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1.0 GENERAL

1.1 Description

This specification along with the drawings covers the furnishing of all materials, products, accessories, tools, equipment, services, transportation, labor, and supervision required for installation of a complete in-place asphaltic concrete paving system.

Work Included:

- a. Final preparation of subgrade
- b. Furnish and place subbase course
- c. Furnish and place base course
- d. Furnish and place asphaltic concrete paving

1.2 Related Sections

1. Section 02510 Site Clearing
2. Section 02230 Specification for Roadway
Excavation, Backfilling

1.3 Quality Assurance

A. Contractor Qualifications

For actual placing and finishing of the asphaltic concrete surfaces and operation of the required equipment, use only personnel who are thoroughly trained and experienced in the skills required.

B. Standards

Specific sections of the Massachusetts Highway Department Standard Specification for Highways and Bridges are referenced in this specification for material selection and method of construction.

1.4 Reference Standards (Latest Edition)

MHD Massachusetts Highway Department Standard
Specification for Highways and Bridges



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SPECIFICATION
FOR ASPHALT CONCRETE PAVING

2.0 PRODUCTS

2.1 Materials

A. Subbase Material

The material shall meet the requirement of Specification 02230

B. Base Course Material

The material shall meet the requirement of Standard Specification 02230.

C. Bituminous Concrete Pavement

Type I-1, meeting MHD Specification Section 460

1. Bituminous material, shall meet MHD Specification M3.11.06
2. Mineral aggregate, shall meet MHD Specification M3.11.04
3. Mineral Filler, shall meet MHD Specification M3.11.05

D. Tack Coat

Tack coat material shall be grade RS-1 conforming to MHD Specification M3.03.0

E. Prime Coat

Prime coat material shall be MC-70 conforming to ASTM D2027.

F. General Composition of Mixture for Paving and Walks

1. The materials forming the asphaltic concrete mixture shall be combined in accordance with the limits of aggregate gradation and asphalt content as specified in MHD Specification M3. Table "A".



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SPECIFICATION
FOR ASPHALT CONCRETE PAVING

2.0 PRODUCTS (continued)

2. A job-mix formula shall be established in accordance with the accepted procedures of the Massachusetts Highway Department. The job-mix formula shall be submitted to the Engineer for approval. After the job-mix is established, all mixtures for the project shall conform within the ranges of tolerances; specified in MHD Specification Section M3.

3.0 EXECUTION

A. Subgrade Preparation

Subgrade shall be shaped to the line, grade, and cross section shown on the drawings. This operation shall include plowing, disking and any moistening or aerating required to obtain proper compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with crushed stone or select material.

B. Placing Subbase Material

1. Spreading

The material shall be deposited and spread upon the completed and approved subgrade in uniform, nearly horizontal layers, without segregation of size, to such loose depth that, when compacted, the total course will have the required thickness.

2. Compaction

- a. Subbase material shall be compacted as outlined in Standard Specification 02230
- b. When material varies from optimum moisture content as too wet, the material shall be drained and worked by plowing or disking until optimum moisture content is attained.
- c. When material varies from optimum moisture content as too dry, the material shall be sprinkled with water and mixed until optimum moisture content is attained.



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SPECIFICATION
FOR ASPHALT CONCRETE PAVING

3.0 EXECUTION (continued)

d. The final surface compaction shall be with a smooth-wheeled power roller to obtain a firm and smooth surface finish.

C. Placing Base Course Material

1. Spreading

If required thickness of the base course exceeds 7 inches, the material shall be placed in two or more layers. If spreading devices such as spreader boxes are used which will ensure proper depth and alignment, forms will not be required. Segregation shall be avoided regardless of the method used.

2. Compaction

After each lift of base course material is spread and shaped, the material shall be compacted as outlined in Standard Specification 02230. The contractor shall use such construction procedures, including sufficient wetting and number of passes of the vibrating roller, to ensure that the above density is attained.

D. Placement of Asphaltic Concrete

1. Transportation and Delivery

a. Conform to requirements of MHD Specification Section 460.61.

b. Asphaltic concrete should not be placed when temperature is below 50°F, nor during fog, rain, snow or other unsuitable conditions.

c. No mixture shall be dispatched from the plant so late in the day that it cannot be spread and compacted in the daylight of that same day.

2. Spreading and Finishing

a. Conform to requirements of MHD Specification Section 460.63.



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SPECIFICATION
FOR ASPHALT CONCRETE PAVING

3.0 EXECUTION (continued)

- b. The surface of which the mixture is spread shall be free from objectionable or foreign material at the time of spreading. Spreading shall be done using a self-propelled asphalt paving machine capable of maintaining line, grade, crown and minimum surface thickness shown on the drawings. The equipment shall also be provided with means for heating the screed members so as to prevent the accumulation of bituminous material.
- c. At locations where it is impractical to use conventional mechanical methods, acceptable hand methods may be used for placing and spreading. Lutes shall be used for spreading. The use of rakes will not be permitted.
- d. Contact surfaces of curbs, gutters, manholes, etc., shall be painted with a uniform coat of hot asphalt cement before material is placed against them.

3. Compacting

- a. After spreading, the compaction, unless otherwise directed, shall be performed with a three-wheel or tandem self-propelled roller having a minimum weight of ten tons. Steel wheel rollers shall be equipped with adjustable scrapers to keep rollers clean and with sufficient means of keeping wheels wet to prevent asphalt from sticking to the rollers.
- b. The rolling should be completed within 30 minutes of the time the material was spread. Compaction, however, must be completed before the temperature of the mixture has dropped below 180°F.
- c. Hand held vibrators or small (PUB) roller shall be used in areas not accessible to self-propelled rollers.
- d. Roll surfaces in two directions if possible and until no roller marks are visible.



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SPECIFICATION
FOR ASPHALT CONCRETE PAVING

3.0 EXECUTION (continued)

- e. The material shall be compacted to obtain a density of not less than 95% of the density obtained by laboratory compaction for the surface course, and a density of not less than 90% of the density obtained by laboratory compaction for the binder course. Laboratory compaction is the average density of the material being placed, obtained by the Standard Marshall Method (50 blows top and bottom face).
- f. The surface of the mixture after compaction shall be smooth and true to the established crown and grade within the tolerances specified.
- g. Finished surfaces shall be free of birdbaths, and shall have no variation greater than 1/8 inch when checked with a 10 foot straight edge.

E. Joints

Comply with MHD Specification Section 460.65.

F. Finish Tolerances

- 1. Finish all surfaces to the following tolerances:
 - a. Subgrade and Base Course - Plus 0.00 feet to minus 0.10 feet from line and grade shown on the drawings.
 - b. Asphaltic Concrete - Plus or minus 0.03 feet at any point from line and grade shown on the drawings.

G. Protection

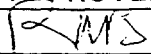

- 1. No vehicular traffic of any kind shall be permitted on any course for 24 hours or as directed by the Engineer.
- 2. All foreign materials which may have accumulated on the surface of any course shall be removed before the course is rolled or before subsequent courses are placed thereon.

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Jacobs Engineering Group, Inc.
Central Region Houston, Texas

®

AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 02672		
			SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION		
BY PF	APPROVED 	ISSUE DATE 9/5/96			
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					SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION	
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PF		9/5/96	0	9/5/96		

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Provide all necessary personnel, equipment and materials required to install extraction wells and reinjection wells with appurtenances, submersible pumps, discharge and reinjection piping and wellhead vaults as shown on the well installation drawings and schedules.

1.1.2 Install well vault, pump, level controls, and all associated piping as defined on drawings.

1.1.3 Develop all wells and sounding tubes to parameters specified herein and pump test all wells prior to installation of remaining equipment.

1.1.4 Conduct performance monitoring of the installed extraction/reinjection well systems.

1.2 RELATED SECTIONS

Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01300	Submittals
Section 03300	Cast-in-Place Concrete
Section 02220	Structural Excavation and Backfill

1.3 REFERENCES STANDARDS (Latest Edition)

1.3.1 Commonwealth of Massachusetts

Guidelines and Policies for Public Water Systems, Commonwealth of Massachusetts, Department of Environmental Protection Division of Water Supply, Revised: October, 1991 / November, 1993, Addendum



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
1.0 GENERAL (continued)			
1.3.2 American Society for Testing and Materials (ASTM)			
ASTM A 53	Specification for Pipe Steel Black and Hot Dip Zinc Coated and Seamless		
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates		
ASTM C 150	Specification for Portland Cement		
ASTM D 653	Terminology Relating to Soil, Rock and Contained Fluids		
ASTM D 1586	Method for Penetration Test and Split Barrel Sampling of Soils		
ASTM D 1587	Undisturbed Sampling		
ASTM D 1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120		
ASTM A 312/312M-946	Standard specification for seamless and welded austenitic stainless steel pipes		
ASTM D 2434	Test Method for Permeability of Granular Soils		
ASTM D 2487	Classification of Soils for Engineering Purposes		
ASTM D 2488	Description of Soils (Visual-Manual Procedure)		
ASTM D 4380	Test Method for Density of Bentonitic Slurries		
ASTM D 4448	Guide for Sampling Ground Water Monitoring Wells		
ASTM D 4750	Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)		
ASTM D 5088	Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites		



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1.0	GENERAL (continued)		
	ASTM D 5092	Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers	
	ASTM D 5521	Guide for Development of Ground Water Monitoring Wells in Granular Aquifers	
	ASTM F 480	Specifications for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratio	
1.3.3	American Welding Society (AWS)		
	AWS D-10.12	Recommended Practices and Procedures for Welding Low-Carbon Steel Pipe	
1.3.4	U. S. EPA Recommended Guidelines		
	EPA OSWER SW-846	Test Methods for Evaluating Solid Waste	
	EPA 570/9-75-001	Manual of Water Well Construction Practices	
1.3.5	Code of Federal Regulations (CFR)		
	Title 29	Occupational Health and Safety Administration (OSHA) 29 CFR 1926/1910	
	Title 40	Environmental Protection Agency	
1.3.6	ANSI/AWWA A-100-90	Standards for Water Wells	
1.4	QUALITY ASSURANCE		
	All work shall be in accordance with EPA 570/9-75-001. Provide each system complete and ready for pump installation including well development and any required aquifer pumping testing.		
1.5	SUBMITTALS		
1.5.1	Submit all documentation in accordance with Section 01300, Submittals.		
1.5.2	Manufacturer's (Approval) Catalog Data		



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

1.0 GENERAL (continued)

- A. Well screens
- B. Casing
- C. Bentonite
- D. Cement
- E. Centralizers
- F. Sand

1.5.3 Statements/Plans (Approval)

- A. Well drilling procedure describing method and equipment for drilling the well.
- B. Well installation procedure describing methods, techniques and equipment to be used.
- C. Well development procedure describing methods, techniques and equipment to be used.

1.5.4 Reports (Record)

- A. Boring logs.
- B. Well alignment test results.
- C. Well completion diagram.
- D. Records of corrective action.
- E. Performance monitoring data.
- F. Well development/test pumping logs.

1.5.5 Certificates (Record)

- A. Mill certificates for all casing.



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SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION

1.0 GENERAL (continued)

B. Mill certificates for all screens.

1.6 PERMITS AND LICENSES

The drilling Subcontractor shall possess a license according to Commonwealth of Massachusetts requirements. All drilling/construction personnel shall meet the training requirements specified in 29 CFR 1910.120, "Health and Safety Requirements." Contractor shall notify the Owner/Engineer and Underground Services Alert to allow sufficient time for utilities to be clearly marked prior to starting work. The Contractor will obtain all necessary permits for the drilling and installation of applicable wells.

2.0 PRODUCTS

2.1 MATERIALS

2.1.1 Well Casing and Screen

A. All blank well casing shall be of carbon steel or PVC, as specified, which conforms to ASTM Standards A53 or F480-94, respectively. All casing shall be of new, first quality material, and free of defects in workmanship and handling. The new casing diameter and material shall be as indicated on the attached well schedule.

B. Well casing shall have flush threaded flush F480 joints with watertight Viton O-ring seals. Casing shall be supplied in 3, 5, 10 and 20-foot lengths. Have on hand at all times sufficient quantities of each length and schedule of pipe to make up any length of blank casing required. Pipe ends shall have protective coverings to prevent damage during transport.

C. Casing pipe shall be epoxy coated, inside and outside to AWWA-A-100-90.



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SPECIFICATION FOR
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2.0 PRODUCTS (continued)

- D. All well screens shall be factory fabricated wire-wound continuous slot type Stainless Steel Type 304 meeting ASTM A312. Trapezoidal or "V"-shaped wire shall be helically bound around an array of equally spaced longitudinal rods and welded at each intersection. The screen slot aperture size and filter pack grain size determination shall be recommended by the contractor. Screen and gravel pack size selections shall be based on the criteria established in EPA 570/9-75-001, Article 49. Submittal drawings for individual wells shall be presented to the Owner/Engineer for approval prior to placement in the well boring. Slot opening may be modified by the Owner/Engineer as required to suit individual wells. Well screen shall be of the same diameter as the above specified well casing. Furnish well screens in 5, 10, and 20-foot lengths. Provide sufficient quantities to make up any length of screen required. Screen lengths and slot size are found on the well schedule and drawings.
- E. Bottom caps/well sumps at the bottom of each well shall be the same material as the well screen and be flush threaded for connection to the bottom section of the screen/sump. The well bottom cap/sump may be fashioned by welding a plate to a short section of threaded casing provided that both plate and casing are stainless steel, and that welding meets ASTM A 312 specifications. Sump lengths shall be 5-feet for extraction wells and 2-feet for reinjection wells.
- F. Provide appropriate isolation coupling when joining the stainless steel screens to the carbon steel well casing riser. The isolator shall be of a material with strength compatibility and inside pipe diameter to that of the well casing.
- G. Provide all parts of each well casing/screen assembly from a single manufacturer.
- H. Under no circumstances will casing thread lubricants, tape, pipe dope or any other potentially contaminating or foreign substance be used during well construction.



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SPECIFICATION FOR
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2.0 PRODUCTS (continued)

2.1.2 Centralizers

A. Well Casing

Well casing centralizers for attachment to the well casing shall be fabricated of 304 stainless steel with 4 bands that expand to fill the annular space as the centralizer is tightened. Centralizers shall be installed just below the bottom of the screened zone, at 20-foot intervals on the screened section, and at 40-foot intervals on the well casing above the top of the screen.

B. In Well Piping

Centralizers (centering guides) for attachment to the extraction well submersible pump discharge pipe and injection well downcomer pipe shall be fabricated from 304 stainless steel or compatible material to which the centering guides will come into contact. The guides shall be of suitable size and stiffness to center the pipe in the well casing to allow for passage of cables and sounding tube, and withstand the rigors of repeated installation, operation and removal of the pipe system. The centering guides will be placed at 40 foot intervals or one per pipe section as a minimum.

2.1.3 Sounding Tube

A water level sounding tube shall be installed within the well casing. The sounding tube shall be constructed of 1-inch nominal inner diameter coiled PVC pipe. Drill 1/4-inch diameter hole 1-inch from the bottom of the open lower end of pipe and install a 3/16-inch stainless steel bolt as a water level probe stop.

The well sounding tube shall extend from three feet above the screened interval of the well to the connection on well cap.

At the top of the tube a barbed/threaded coupling will be welded into the well cap. The PVC pipe will be attached to the barbed connection. Install a threaded pipe nipple with end cap above the well cap. Secure sounding tubes to pump discharge line with plastic ties. Installation of the sounding must allow for insertion and passage of a 1/2-inch diameter by 7-1/2-inch long probe.



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
2.0 PRODUCTS (continued)			
2.1.4 Filter Pack			
<p>Clean and sanitized granular materials used for filter packing shall meet the requirements of the AWWA A 100-90 standard and have Natural Sanitation Foundation (NSF) listing. Tests for gradation of filter pack material shall be performed according to the method of testing specified in ASTM C136. The uniformity coefficient of the filter pack shall not exceed 2.5.</p> <p>Granular materials size determination/recommendations shall be made by the drilling contractor for each well installed. Sieve analyses shall be completed on formation samples collected at a minimum individual of 5 feet throughout the entire length of well screen, plus 15 feet above the screen.</p> <p>Submit to the Owner/Engineer certified laboratory test results verifying conformance of the filter pack material to the specifications along with the 5-pound sample of the material before it is delivered to the site.</p>			
2.1.5 Transition Sand			
<p>Silica sand placed directly above the filter pack shall be as specified for the Filter Pack except that less than 1 percent by dry weight shall pass the No. 100 sieve and 100 percent shall pass the No. 50 sieve.</p>			
2.1.6 Bentonite Seal			
A. Powder Slurry Seal			
<p>Bentonite in powder form for preparing the slurry seal or grout mix shall be a high swelling finely ground sodium montmorielinate such as produced by American Colloid Company, Skokie, Illinois, or equal.</p>			
B. Pellet Seal			
<p>Bentonite for the sealing of the wells may be in granular form such as TR-30 (deep well pellets) by PDS-Arkansas or equal as approved by the Owner/Engineer. Above water level bentonite pellet seals shall be installed and hydrated to ensure sealing of the bore.</p>			



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
2.0 PRODUCTS (continued)			
2.1.7 Grout Mix			
<p>Grout shall consist of a cement/sand/bentonite slurry. Portion one bag of cement to not more than 6 gallons of water. Four to five (4 to 5) pounds of powdered bentonite per bag of cement may be used to reduce shrinkage. Add 20 - 40 sieve sand at 1:1 ratio as appropriate. Consistency and method of mixing shall be approved by the Owner/Engineer. The use of special cements or other admixtures (ASTM C 494) to reduce permeability, increase fluidity, and/or control set time, and the composition of the resultant slurry shall be approved by the Owner/Engineer. The density of the slurry mixture for tremie grouting shall be monitored prior to placement (using a standard mud balance). A record shall be kept of all such measurements. The time between mixing and placement and the total volume of slurry emplaced shall also be recorded.</p>			
A. The cement shall conform to ASTM Designation C 150 Type I or II Portland Cement.			
B. Powdered bentonite for the grout mix shall be as specified for the bentonite slurry seal.			
C. Water used for mixing of grout shall be potable water, with its source approved by the Owner/Engineer.			
2.1.8 Temporary Wellhead Protection			
<p>A temporary protective cover shall be installed, if required to secure the well heads, until surface completion can be accomplished. Protective cover size and type shall be approved by the Owner/Engineer.</p>			
2.2 EQUIPMENT			
2.2.1 Wellhead Vault			
<p>A wellhead vault will be provided at each well location as shown on the installation drawings.</p>			



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

2.0 PRODUCTS (continued)

2.2.2 Submersible Pump

A submersible pump with associated piping and power cable shall be installed in each extraction well as shown on the well schedule and installation drawings in scope of work. Pump type and size shall be per the specifications. The discharge pipe shall be centered inside the casing with pipe guides spaced every 40 feet. The wiring that connects to the pump motor along with the steel safety cable to support the pump assembly shall be fastened to the downcomer pipe at approximately 10-foot intervals. Fasteners may be accomplished using plastic cable ties.

2.2.3 Wellhead Piping Assembly

Extraction and injection wellhead piping assemblies in the vault shall be constructed and installed as shown on the piping drawings and specifications.

A. Injection Well Downcomer Pipe

The downhole delivery system (downcomer pipe) shall deliver the specified flow rate for each well without generating vacuum conditions in the pipe system. The downcomer pipe shall have a 2-inch inner diameter and extend from the discharge end at a depth approximately 2-feet above the top of the screen to a flanged connection located above the top of the well cap. The bottom of the pipe shall have a diffuser to reduce turbulence in the well. The pipe shall be centered inside the casing using pipe guides spaced approximately every 40 feet. The top of the pipe must be flanged and capped so as to allow later connection of the incoming piping system, in accordance with the well schedule and installation drawings.

B. Extraction Well Pump Discharge Pipe

The submersible pump discharge piping shall convey pumped water from the pumps to the discharge piping connection above the wellhead. The pipe shall have threaded connections and be of a diameter to match the submersible pump discharge connection. The pipe shall have screwed connections and extend to the flange connection above the well cap as shown on the groundwater extraction well details. The pipe shall be capable of supporting the submersible pump and piping to the depth as shown on the extraction well schedule. Piping material size and assembly shall be as shown in the well schedule and detail drawings.



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
2.0 PRODUCTS (continued)			
C. Wellheads			
Extraction Well Wellhead			
<p>The top of the extraction well shall be fitted with a flanged steel well cap as shown on the attached drawing. The cap shall be sealed to the well casing and have sealed penetrations for submersible pump discharge piping, power cables and control wiring. A 1-inch diameter sounding tube shall be installed through the well cap in accordance with Article 2.1.3. A stainless steel safety cable shall be securely attached to the bottom of the cap and of sufficient length and strength to be of use in removing the submersible pump in an emergency. The Contractor shall ensure that the appurtenances do not interfere with each other.</p>			
Injection Well Wellhead			
<p>The top of each injection well shall be fitted with a compression seal steel cap as shown on attached detail drawing. Bolts shall connect the cap and compression collar to an expanding neoprene seal so as to provide a snug fit inside the casing. The seal and the cap shall contain a centered hole in which the injection pipe coupling will be welded. The injection pipe shall be extended 9-inches above the cap with a raised face flange connection. A 1-inch (minimum) diameter sounding tube will also be installed through the well cap, in accordance with Article 2.1.3. A 3/4-inch diameter steel vent pipe with ball valve shall be installed through the well cap. A stainless steel safety cable shall be securely attached to the bottom of the cap and below the lowest center guide. It shall be of sufficient strength to remove the downcomer pipe in an emergency. The Contractor shall use appropriate care to ensure that all appurtenances do not interfere with each other.</p>			



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
3.0 EXECUTION			
3.1 PREPARATORY INSPECTION			
3.1.1 Site Conditions			
Verify work site conditions and conduct all preparatory inspections necessary to determine that full extent of the work required to make the completed installation conform to the drawings and specifications. Discrepancies or inaccuracies that will prevent full prosecution of the specified work shall be resolved prior to commencement of the work.			
3.1.2 Materials			
Verify that necessary materials are on site, properly stored and the required documentation has been received and applicable submittals have been approved.			
3.1.3 Equipment			
Verify that all equipment for well bore drilling, well installation, well testing and waste materials management is available and operational.			
3.1.4 Personnel			
Verify that all personnel are current on HAZWOPER training and that medical monitoring is up to date.			
3.2 PREPARATION			
3.2.1 Regulatory Requirements			
Well driller shall have a current Commonwealth of Massachusetts Driller License/Certification as (if) required.			
Comply with Massachusetts DEP, Division of Water Supply Guidelines and Policies for Public Water Systems, 1991/1993 as applicable.			
Comply with any other local applicable Commonwealth and Federal regulations not specified herein.			



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

3.0 EXECUTION (continued)

3.2.2 Preparatory Meeting

Conduct Preparatory Phase Meeting with Owner/Engineer to finalize coordination of materials, potable water, waste management, quality control, well installation, well development and well pumping tests.

3.2.3 Condition of Equipment

All equipment and materials shall be in good operating condition at all times and operated and maintained in strict conformance with manufacturers' recommendations.

3.2.4 Decontamination

All prefabricated equipment and related accessories shall be decontaminated at the place of manufacturer and shipped to the Contractor in hermetically sealed packages. If the packages tear or otherwise become ineffective in sealing the equipment from contamination, decontaminate those materials as required before placing down well.

All drilling equipment in contact with the well bore, screens and casings used for wells subject to water sampling shall be in a sterile and contaminant free condition when placed into the ground. Steam clean well materials, with potable water only, prior to installation in the borehole and protect by wrapping in plastic or placing on clean surface while holding for down hole placement.

Drilling equipment in contact with the borehole materials shall be decontaminated between well fence locations to prevent cross-contamination.

Contractor shall coordinate decontamination point or approval of decontamination apparatus/system with the Owner/Engineer.

3.2.5 Training

Contractor shall have the appropriate equipment and trained personnel to perform the extraction/injection well installations and well development as specified herein.

3.2.6 Site Geology Review

Contractor shall review the site geology with the Owner/Engineer for potential wellbore drilling and well casing installation problems.



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
3.0 EXECUTION (continued)			
3.2.7 Wellbore Siting			
<p>Contractor shall verify location of each well bore with the Owner/Engineer. The exact depth below ground surface will be reviewed, interpreted and finalized from the well schedule and field survey data.</p>			
3.2.8 Staging and Storage Areas			
<p>Any onsite staging and storage areas that are necessary during site activities shall be approved by the Owner/Engineer. Drill cuttings may be temporarily stored at the Subcontractor's temporary storage area or disposed of as approved by Owner/Engineer.</p>			
3.2.9 Water Source			
<p>The Construction Manager will identify one source of potable water for use during drilling and well installation. The Contractor shall be responsible for obtaining the water from the designated source and transporting the water to the drilling site. The Contractor shall be responsible for providing all deionized water required to perform the work.</p>			
3.2.10 Waste Management Coordination			
<p>Contractor shall ensure that sufficient containers are present and positioned for collecting drill cuttings, drilling fluids, well development water and well pumping discharge water. Coordinate with Owner/Engineer for appropriate sampling and disposal of cuttings and liquids.</p>			
3.2.11 Grid Stake Protection and Property Damages			
<p>Subcontractor shall protect and maintain survey and grid stakes as well as the property of others against damage from equipment and vehicular traffic. Any damage shall be repaired by the Subcontractor at the Subcontractor's expense.</p>			



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
3.0 EXECUTION (continued)			
3.3 INSTALLATION			
3.3.1 Wellbore Drilling Method			
<p>The preferred drilling method for extraction and reinjection wells is cased drilling techniques. The essence of this preferences is to stabilize the borehole during drilling, minimize borehole wall disturbance, and improve well development time. Drilling techniques requiring the use of drilling fluids other than clean, potable water will not be allowed.</p> <p>The contractor shall maintain well plumbness and alignment as defined in the AWWA A-100-90 standard. The AWWA A100-90 standard will be strictly adhered to in order to evaluate the acceptability of the extraction and reinjection wells. Completed wells not meeting the maximum allowable horizontal deviation from the vertical may be reinjected. The drilling contractor will not be compensated for borings deemed unacceptable because of poor plumbness and alignment. Well construction casings installed for the purpose of placing the gravel pack material will be tested for plumbness. Completed well casings will be tested for alignment.</p> <p>Cuttings shall be discharged onto heavy plastic laid on the ground. Monitor and dispose of cuttings as specified in Article 3.11, Disposal of Cuttings and Well Development Water in this section. Stop hole advancement as directed by the Owner/Engineer. All loose soil material shall be removed from the hole.</p>			
3.3.2 Borehole Logging			
<p>During the progress of each boring, keep a continuous and accurate log of the materials encountered and a complete record of the operation of installing the well casing. Soil cuttings observed shall be described on a boring log in accordance with Unified Soil Classification System. (The Contractor shall be aware of hole depth at all times and shall inform Owner/Engineer of the same upon request.)</p> <p>Records shall include at least the following data:</p> <ul style="list-style-type: none">A. Names of driller and inspector.B. Dates and times of beginning and completion of work.C. Identifying number and location of test boring.			



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**SPECIFICATION FOR
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3.0 EXECUTION (continued)

D. Diameter and description of casing.

E. Total length of each size of casing.

F. Length of casing extending below ground surface at the completion of the boring.

G. Depth to top of each different material penetrated.

3.3.3 Well Boring Location/Size/Depth

The well boring shall be drilled at location shown on drawing and to depth as specified in the well schedule or as directed by the Owner/Engineer.

The boring diameter shall be of sufficient size to allow for the accurate placement of the screen, well casing, centralizers, sounding tube, filter pack, tremie pipe, seals, filter pack and grout.

3.3.4 Wellbore Flushing

After the completed depth is reached and the borehole is stabilized the borehole shall be flushed to remove suspended cuttings. Drill rods or drill casing shall be removed in such a manner (e.g. vented hoisting swivel) that minimizes the creation of differential pressures in the borehole fluid and the formation. (No payment will be authorized by the Owner/Engineer for redrilling due to localized caving and hole collapse caused by bit-swabbing damage or negligence.)

3.3.5 Well Casing Assembly and Installation

The extraction well/reinjection well casing will be assembled and placed down borehole as specified and as shown on the attached drawings. Assembly will include bottom cap, screen, riser casing and centralizers. Assembled well casing will be suspended from surface in a manner to preclude accidental movement during backfill of annular space. (Do not force assembly down hole.)

3.3.6 Sealing Borehole Bottom

If borehole was overdrilled, it shall be sealed to the bottom of the filter pack elevation with a bentonite slurry seal. The slurry seal shall be allowed to set-up so that it does not contaminate the filter pack.



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

3.0 EXECUTION (continued)

3.3.7 Filter Pack Placement

Pack the annular space around each well screen with the specified filter pack material to the level shown on the installation drawings.

Exact placement of the filter pack will depend on field conditions, but in general the filter pack will extend from a depth of 5 feet below the bottom of the screened to 10 feet above the top of the screened interval. The filter pack shall be installed through a tremie pipe placed so that sand will not drop more than 10 feet below the bottom of the tremie. The depth to the top of the sand will be continuously sounded using a weighted measuring line as the filter pack is installed. Outer drill casing or casing pipe, will be raised periodically as the filter pack is installed, taking care to ensure that the top of the sand is always above the bottom of the outer drill casing being removed/lifted.

After initial filter pack placement, the inside of the well screen will be gently swabbed for approximately 15 minutes to encourage settling of the newly installed filter pack. Additional material will then be added until the top of the filter pack is at the correct depth.

Any water added to tremie the sand shall be potable grade obtained in accordance with Article 3.2.9 Water Source. All filter pack material shall be protected from contamination prior to placement by either storing it in plastic-lined bags or in a location protected from the weather and contamination on plastic sheeting. All filter pack materials shall be transported to the well site in a manner that prevents contamination by other soils, oils and grease, and other chemicals.

3.3.8 Transition Sand Placement

Pack the annular space around the casing above the filter pack with the specified transition sand to a thickness of not less than 2 feet using the same techniques as for the filter pack.



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

3.0 EXECUTION (continued)

3.3.9 Bentonite Seal Placement

A minimum 5 foot bentonite slurry seal consisting of Volclay grout (or approved equal) shall be tremie injected into the specified interval above the transition sand after the sand has been allowed to settle. Prepare the slurry in a mixing plant at the bentonite powder to water ratio recommended by the manufacturer. The quantity of slurry will be calculated on the basis of filled annulus. Measure the consistency of the slurry using a mud balance, such as those manufactured by American Colloid Company. After the bentonite slurry seal is installed to the correct depth and the outer casing is raised so that the bottom of the casing is at the top of seal, the bentonite slurry seal shall be allowed to set-up for a period of at least one hour before any other activity on the well is performed.

3.3.10 Borehole Annulus Closure

The well casing and sounding tube shall have a minimum of 1 1/2 foot stick-up above ground surface. The borehole annular space from the top of the bentonite slurry seal to approximately 20 feet below the finish grade (bottom of vault) shall be filled with native sand (non-contaminated drill cuttings). All non-native backfill of boring must be approved by the Owner/Engineer.

3.3.11 Wellhead Completion

The final 20 feet of annular space to bottom of vault shall be grouted with a cement/bentonite slurry in accordance with Article 2.1.7. The top of the grout will be set at the T.O.C. (top of concrete) elevation of wellhead vault slab. The space between the grout and the vault floor slab shall be filled and finished during installation of the vault. (**Important Note:** All annular grout placed above the finished vault floor elevation will have to be removed. See wellhead vault detail on attached drawings.)

3.3.12 Well Development

Well development shall be performed as soon as practical after installation, but no sooner than 24 hours after grouting is completed. The following goals are established for determining that well development is satisfactory:



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
3.0 EXECUTION (continued)			
A. Well Development Goals			
<ul style="list-style-type: none">The first requirement is hydraulic in nature and assures that the well is hydraulically efficient, meaning that minimal head loss will occur due to formation disturbance during drilling. The recommended procedure is to surge the well for 1/2 to 1 hour, let the water level in the well recover fully, and then pump the well at a constant rate for a fixed time (e.g., 20 minutes). Pumping rate during development shall be 1.5 times the design flow rate for the well. A half-hour should be sufficient for water level recovery, but measurements of water elevation must be made to confirm a return to equilibrium. This development-test cycle is repeated as many times as necessary until the ending drawdowns for two successive cycles are essentially the same (no further reduction in drawdown). The rate of pumping shall be held constant from one cycle to the next. The hydraulic requirement for extraction well development is met when drawdown reduction ceases, assuming the well has been adequately stressed by the development method.A second requirement is that the wells will be developed until the water is generally clear and free of silt. Five Nephelometric Turbidity Units (NTUs) will be used as a goal for well development. Turbidity shall be measured with a portable turbid meter such as that manufactured by Hach (model 2100P) or approved equal.The wells shall be developed by alternately pumping and surging using the airlift pump or turbine pump with surge block installed to the development pipe. A hydrocarbon air filter shall be used within the airlift system. Water generated during development of the extraction wells shall be managed per Article 3.11, Disposal of Drill Cuttings and Well Waste Water.			



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3.0 EXECUTION (continued)			
B. Well Development by Surging:			
<ul style="list-style-type: none">Well development by surging shall be completed with a spudding action (up and down motion) by using either a single or double solid or valved surge block. The spudding action shall be a minimum of 30 strokes per minute. The surge block is lowered until it is below the static water level and a relatively gentle surging action is begun. As water begins to move easily in and out of the well screen, the length of stroke of the surge block is increased, thus increasing the force of the surging movement. Surging shall proceed from top of screen to bottom in a manner to prevent the surging tool from becoming sand blocked or causing damage to the screened section. If the surging action causes the disruption of the seal around the casing, use of the surge block must be discontinued. <p>When accumulated sediment reaches a depth of one (1) foot in the lower screen length, the sediment shall be removed by bailing or other appropriate method before well development continues. Well development shall continue until the water is relatively free from sand, silt, and turbidity, and the water pH, conductivity, and temperature are stable, within 10% over three successive water grab samples. Final approval of the well development shall be by the Owner/Engineer.</p>			
C. Well Development by Airlift			
<ul style="list-style-type: none">The airlift method shall consist of a system which prevents spraying of contaminants into the air. It may be necessary to install an eductor pipe in the well. The eductor pipe system will minimize the chance to letting a large burst of air injected into the well screen intake area to be projected into the formation. For 6 inch extraction wells, the recommended sizes of the eductor pipe and air line are 4 inches and 1-1/4 inches, respectively.When accumulated fines reach a depth of one (1) foot in the lower screen length, the fines shall be removed by bailing, pumping or other appropriate method before well development continues. Well development shall continue until the water is relatively free from sand, silt, and turbidity, and the water pH, conductivity, and temperature are stable, within 10% over three successive water grab samples. Final approval of the well development will be by the Owner/Engineer.			



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

3.0 EXECUTION (continued)

3.4 WELL PERFORMANCE TESTING

A well performance pumping test shall be performed by the Contractor in all of the new extraction and injection wells. The pumping tests are intended to assure that installed wells function properly identify sand production problems, and to determine the wells' capacity. The extraction wells shall be step-tested to determine specific capacity. Each well must be able to pump at the maximum pumping rate specified by the Owner/Engineer. Each well shall recover from development procedures for a minimum of 24 hours prior to the well test. All test results (drawdowns and pumping rates) shall be submitted in support of pump design.

3.4.1 Equipment

The Contractor shall install a temporary pump capable of producing up to twice the design flowrate of the well and all other temporary support equipment as required to perform the test. The Contractor shall assume all liability for damage to the pump from sand entering the well. The pump shall be set to within 3 feet of the bottom of the well screen. The Contractor shall furnish a calibrated flow meter and accessories necessary to accurately measure up to the maximum flow from the pump.

3.4.2 Sand Content Test

Following development, the extraction well shall be pumped at the approximate design flow rate until turbidity levels have stabilized. After pumping at this rate for 2 hours, the sand content shall not exceed 5 milligrams per liter (mg/l) of water as determined for a sample of water representative of the entire flow in the discharge line. Sand content is defined as the dry weight of material retained by the #200 sieve per volume of water. If the sand content is still 5 mg/l or greater after 2 hours, development shall resume until sand content is reduced to 5 mg/l. When the sand content criterion has been met, the well shall be overpumped at a discharge rate approximately 50 percent greater than the design rate for 15 minutes. Samples of suspended sediments shall be collected and measured.



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

3.0 EXECUTION (continued)

3.4.3 Step-Drawdown Tests

After installing appropriate pumping equipment in the well, the Contractor shall conduct step-drawdown tests before performing other tests. After measuring the static water level in the well, commence pumping at a constant rate (\pm 5 percent) equal to 1/4 of the design flowrate of the well and continue for 2 hours or shorter (i.e., one hour) until the drawdown at the well is stabilized. Water levels shall be measured and recorded during the test every 30 seconds for the first five minutes, then every minute for the next five minutes, then every five minutes for 10 to 45 minutes, then every 15 minutes for 45 to 120 minutes. The sounding tube shall be used for measuring water levels. The pumping rate shall then be increased to the 1/2 of the desired production rate and continued for another one or two hours. Measurements shall be taken according to the same schedule as previously described. This shall be repeated for the 3/4 production and full production rate.

Immediately following this step, two additional steps shall be conducted according to the same production increase rate, to determine if the well has sufficient capacity to produce at those rates for the required time (120 minutes). If the pump breaks suctions at a pumping rate prior to the two hours, subsequent steps at higher rates need not be attempted; however, the flow rate shall be reduced until the water level, while pumping stabilizes at least 2 feet above the pump intake and the test shall be continued for the remainder of the two hours. Discharge water must be contained in a sufficiently large tank(s), transported and discharged as described in Article 3.11, Disposal of Drill Cuttings and Well Wastewater.

3.5 QUALITY CONTROL

3.5.1 Field Inspections

Field inspections shall be performed by Contractor to qualitatively assess the work and materials including, but not limited to the following:

- A. Visual inspection of all materials used and the review of all material certifications before they are placed down hole.
- B. That all down hole materials and equipment is properly decontaminated and protected from contamination during transport and installation.
- C. That screens and casings for wells, subject to water sampling, were kept in a sterile and contaminated free condition until placed in the ground.



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**SPECIFICATION FOR
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3.0 EXECUTION (continued)

D. That drilling equipment is properly decontaminated to prevent cross contamination from previous boreholes.

E. That ground surface is protected from drilling fluid/waste contamination during well installation and the drilling/development fluids and other generated wastes are properly contained.

F. That the well installation meets the requirements of this section.

G. That the final borehole/well depth is placed according to attached well schedule and confirmed by the Owner/Engineer.

H. That a boring log/monitor well record is maintained for each borehole.

I. That a well completion record was prepared for each well installed during the actual well installation.

J. That the boring log and well completion records are submitted as required to MADEP with duplicate copies provided to the Owner/Engineer.

3.6 WELLS PROTECTION AND IDENTIFICATION

At all times during the progress of the work, precautions shall be used to prevent tampering with the well or the entrance of foreign material into it. Wellheads/vaults shall be locked and kept secure at all times. A metal tag shall be affixed to the well cap. The metal tag shall be stamped with the well identification number and the top of casing elevation (in msl feet) as determined by the Contractor's surveyor. The Contractor shall provide 2 sets of keys per wellhead lock to the Owner/Engineer.

3.7 GROUNDWATER OBSERVATIONS

Observations and recording of water levels during and at the completion of the drilling operations on a site shall be made according to the following guidelines:

A. Date, time, and depth from the ground surface to the first encountered water surface.

B. Notes pertaining to any noticeable loss or rise of water during the advancing of a boring, to include date, time, and depth to which the water dropped in the boring or height to which it rose in the casing.



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**SPECIFICATION FOR
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3.0 EXECUTION (continued)

C. Date, time, and depth to the water surface at the completion of each borehole, both immediately before removing the casing and before leaving the boring location after the drill casing has been removed.

D. Notes regarding weather: rain, snow, clear; temperature (estimate to nearest 10° F).

E. Notes regarding any special drilling techniques or procedures, such as the use of any drilling fluids other than water.

3.8 ABANDONMENT AND COMPLETION OF BORINGS

A. Borings shall not be abandoned before reaching the final depth authorized by the Owner/Engineer except with the approval of the Owner/Engineer.

B. Borings abandoned before reaching required depth, because of an obstruction or other reasonable cause not permitting completion of the boring by supplementary boring adjacent to the original boring, may be made by means other than specified only with the Owner/Engineer approval.

C. Abandoned borings may be allowed to collapse and backfilled with native sand. In the event contaminated soil is encountered, the borehole will be cement grouted from the water table to ground surface. No grouting will be permitted below the water table.

3.9 DRILLING FLUIDS, SOLVENTS, GLUES AND LUBRICANTS

Do not use any drilling fluids other than potable water unless specifically approved by the Owner/Engineer. No glue or welding solvents will be allowed in casing assembly. Do not use oil, grease, or other petroleum derived, lubricants on drill rods, tools, and casings. Any material employed as a drilling fluid or lubricant shall be approved by the Owner/Engineer prior to its use.



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**SPECIFICATION FOR
EXTRACTION AND REINJECTION WELL INSTALLATION**

3.0 EXECUTION (continued)

3.10 DECONTAMINATION

All drill rigs, pumps, and tools (casing and rods) shall be steam cleaned, and if necessary, scrubbed with tri-sodium phosphate (TSP) and potable water prior to setting up at the drilling location and prior to site departure. More frequent decontamination of rigs may be required depending on actual exposure to contaminated conditions. Containerize decontamination water if cuttings generated during drilling are determined to be contaminated as described in Article 3.11, Disposal of Cuttings and Well Waste Water. Alternative decontamination procedures and methods shall be approved by the Owner/Engineer prior to their use. Perform decontamination at a specially designated decontamination area as authorized by the Owner/Engineer.

3.11 DISPOSAL OF DRILL CUTTINGS AND WELL WASTE WATER

3.11.1 Monitor cuttings generated during drilling with a PI meter for evidence of contamination.

A. If PI meter readings are lower than 5 ppm in the ambient air above the cuttings, dispose of the cuttings on-site in the immediate vicinity of the boring by spreading out level on the ground surface upon completion of drilling.

B. If PI meter readings are higher than 5 ppm, segregate cuttings and decontamination fluids in DOT approved containers (Spec 17H for soils and 17E for fluids) supplied by the Contractor and transport, at the end of activity or each day, to the Otis ANG hazardous waste storage facility, Building 204, located on the MMR. All drummed materials will become the property of MMR; characterization and drum disposal will be the responsibility of MMR.

3.11.2 Well Waste Water

Containerize all well development and pumping test water and test for the four organic contaminants of concern by GC method or other method approved by the Owner/Engineer.

A. If contaminant concentrations are below treatment facility target clean up levels, discharge the water onto the ground.



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SPECIFICATION FOR EXTRACTION AND REINJECTION WELL INSTALLATION			
3.0 EXECUTION (continued)			
B. If concentrations are greater than target clean up levels, the water shall be either:			
Discharged through the groundwater treatment system when operational;			
Appropriately characterized, containerized, transported and disposed off-site.			
Ensure all transportation and disposal means and methods comply with all state and Federal regulatory authorities. Furnish Owner/Engineer with written documentation and records verifying receipt and the quantity received of each load at the disposal facility and verification of proper disposal.			
3.12 WELL RELOCATIONS			
In the event that the soil or groundwater is determined to be contaminated the Owner/Engineer reserves the right to abandon and relocate well locations as described in the article entitled Abandonment and Completion of Borings as specified in this section.			
3.13 WELL ACCEPTANCE			
It is the responsibility of the Contractor to properly construct and install, develop, and test all wells according to the requirements of these specifications so that they are suitable for the intended purpose. If the Contractor, due to his negligent construction, installs wells that are not functional or not in accordance with specifications, the Owner/Engineer will disapprove the well and direct the Contractor to repair it at the Owner/Engineer's discretion. This work shall be done at no additional cost to the project.			

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Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00				NO: 02831	
BY MHH		APPROVED <i>BIB</i>	ISSUE DATE 8/23/96	SPECIFICATION FOR CHAIN LINK FENCING	
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BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR CHAIN LINK FENCING	
MHH		8/23/96	0	8/23/96		

1.0 GENERAL

1.1 Description

This specification along with the drawings covers the furnishing of all material, equipment, accessories, tools, services, transportation, labor, and supervision required to install a complete chain link fencing system.

A. Work Included

1. Delivery of material to job site with proper handling and storage.
2. Installation of chain link fencing and hardware.
3. Installation of gates.
4. Installation of barbed wire security extensions and barbed wire.

B. Related Work by Others

1. Clearing and grading.
2. Finished hardware such as padlock and other devices which are not an integral part of the gate latch system.
3. Electrical hook-up for electrically operated gate.

C. Definition

1. Security Fence

Security fence shall be 7 feet high plus 3 strands of barbed wire for a total height of 8 feet.

1.2 Quality Assurance

A. Contractor Qualification



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**SPECIFICATION FOR
CHAIN LINK FENCING**

1.0 **GENERAL** (continued)

1. The installer must be experienced in chain link fence installation and must examine conditions under which fence and gates are to be installed.

2. All work shall be executed with good workmanship and produced by methods recognized as reliable industrial practices.

1.3 **Unloading and Handling**

 All materials shall be unloaded and handled with reasonable care. Avoid dragging materials over gravel or paved surfaces.

1.4 **Submittals**

 None.

1.5 **Reference Standards (Latest Edition)**

1. ASTM A 90: Standard Test method for weight of coating on zinc coated (galvanized) iron or steel articles.

2. ASTM A 121: Standard specification for zinc-coated (galvanized) steel barbed wire.

3. ASTM A 123: Standard specification for zinc (hot-dip galvanized) coatings on iron and steel products.

4. ASTM A 153: Standard specification for zinc coating (hot-dip) on iron and steel hardware.

5. ASTM A 491: Standard specification for aluminum coated steel chain-link fence fabric.

6. ASTM A 585: Standard specification for Aluminum coated steel barbed wire.

7. ASTM A 641: Standard specification for zinc coated (galvanized) carbon steel wire.

8. ASTM C 33: Specification for concrete aggregates.



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SPECIFICATION FOR CHAIN LINK FENCING			
2.0 <u>PRODUCTS</u>			
2.1 <u>Framing Materials</u>			
A. <u>Steel Framing, Posts, Gates, Rails, and Braces</u>			
1. All structural and roll-formed shapes shall conform to the provisions of ASTM A123 for galvanizing. Zinc weight shall be determined in accordance with ASTM A90.			
2. All tubular members shall comply with the provisions of ASTM A120, Schedule 40, for weight and coating.			
B. <u>Line Posts Spacing</u> (10'-0" maximum)			
1. Fabric up to and including 8'-0" in height: 1.875" x 1.625" x 0.121" thick roll-formed "C" section or 2" Schedule 40 (2.375 OD) pipe.			
2. Fabric between 8'-0" and 12'-0" in height: 2.25" x 1.70" x 0.121" thick roll-formed "C" section or 2-1/2" Schedule 40 (2.875 OD) or pipe or H-Post weighing 4.1 plf.			
C. <u>End, Corner, and Pull Posts</u>			
1. Fence up to and including 12'-0" in height: 3.5" x 3.5" x 0.1345" thick roll-formed corner section or 2-1/2" Schedule 40 (2.875 OD) pipe.			
2. Pull Post: Every 500 feet.			
D. <u>Swing Gate Posts</u>			
a. Gate leaves up to and including 6'-0" wide. 3.5" x 3.5" x 0.1345" thick roll-formed corner section or 2-1/2" Schedule 40 (2.875 OD) pipe.			
b. Gate leaves 6'-0" and up to and including 13'-0" wide. 3-1/2" Schedule 40 (4.000 OD) pipe.			
c. Gate leaves over 13'-0" and up to and including 18'-0". 6" Schedule 40 (6.625 OD) pipe.			



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SPECIFICATION FOR CHAIN LINK FENCING				
2.0 <u>PRODUCTS</u> (continued)				
d. Gate leaves over 18'-0" and up to and including 30'-0". 8" Schedule 40 (8.625 OD) pipe.				
E. <u>Slide Gate Posts</u>				
(Roll or overhead slide) with openings to and including 60'-0". 3-1/2" Schedule 40 (4.0 OD) pipe.				
F. <u>Slide Gate Posts</u>				
(Cantilevered) for openings to and including 40'-0". 3-1/2" Schedule 40 (4.0 OD) pipe.				
G. <u>Top Rails</u>				
1.625" x 1.25" x .0747" thick roll-formed section or 1-1/4" Schedule 40 (1.660 OD) pipe.				
H. <u>Bracing</u>				
One brace assembly shall be used for each end or gate post and two brace assemblies for each corner or pull post.				
Tension braces shall be 3/8 inch diameter or larger galvanized steel truss rods with turnbuckle adjustment and with fittings corresponding to the type of post used. The braces shall extend from a line post to the related gate, corner, pull or end post.				
Compression braces shall be 1.66 inch OD (2.27 lb/ft) field cut, with end fittings corresponding to type of post used. The braces shall extend to the adjacent line post at the height of fabric or at a height as recommended by the manufacturer.				
I. <u>Top and Bottom Tension Wires</u>				
No. 7 gauge galvanized steel spring coil wire having a zinc coating of 1.6 ounce per square foot of surface area. For PVC coated fabric use 6 (0.192") gauge PVC coated tension wire.				



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SPECIFICATION FOR CHAIN LINK FENCING			
2.0 <u>PRODUCTS</u> (continued)			
J. <u>Tension Bars</u>			
1/4 inch x 3/4 inch galvanized steel bar. Length to be 1 inch less than full height of fabric.			
K. <u>Tension Bands</u>			
1/8" x 1" galvanized carbon steel with beveled edges, spaced at intervals not exceeding 15 inches.			
L. <u>Post Tops</u>			
Pressed steel or malleable iron, designed as a weathertight closure cap for all posts.			
M. <u>Fittings</u>			
All fence fittings shall be malleable iron and hot dipped galvanizing conforming to ASTM A153.			
N. <u>Bolts - Nuts</u>			
3/8" galvanized steel carriage bolts and hex nuts and hot dipped galvanized conforming to ASTM A153.			
O. <u>Barbed Wire Supporting Arms</u>			
1. Heavy pressed steel or malleable iron, complete with provisions for anchorage to tubular end, corner, and pull posts attaching 3 rows of barbed wire to each arm. Barbed wire arms are not required on terminal posts. Single 45° arms shall be integral with a post top weather cap. Arms shall be capable of withstanding, without failure, 250 pounds downward pull at outermost end of arm.			
2. On terminal posts, the post is extended to receive the 3 strands of barbed wire. The barbed wire changes from a 45° plane to a vertical plane at these locations.			
3. Supporting arms shall be faced outward.			



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**SPECIFICATION FOR
CHAIN LINK FENCING**

2.0 PRODUCTS (continued)

P. Barbed Wire

1. Three strands running the entire length of fence above fabric, including gates; each strand consisting of two 12-1/2 gauge wire with 14 gauge, 4 point, round barbs spaced approximately 3 inches on center for heavy security.
2. Finish shall be:
 - a. Galvanized ASTM A121, Class 3 for galvanized and PVC coated fabric.
 - b. Aluminized finish, ASTM A585, Class II for aluminum coated fabric.

2.2 Fabric

A. Aluminum-Coated Steel Wire Fabric

Chain link fabric shall be woven from 9 gauge (.0148") (coated size) wire in a 2 inch mesh conforming to ASTM A491. Minimum coating weight shall be .40 oz/sq. ft. of wire surface.

C. Selvage Edges

Top selvage barbed and twisted, and bottom selvage knuckled.

D. Ties

1. Fasten galvanized and aluminized fabric to line posts with 9 gauge aluminum wire ties 14 inches apart and to tension wires with 11 gauge galvanized hog rings at intervals not exceeding 24 inches.
2. Fasten PVC coated fabric to line posts with PVC coated steel ties at intervals not to exceed 15 inches. Fasten PVC fabric to tension wire at intervals of 24 inches with PVC coated hog rings.



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SPECIFICATION FOR
CHAIN LINK FENCING

2.0 PRODUCTS (continued)

2.3 Gates

A. Fabrication

1. Fabricate gate perimeter frames of 1-1/2" Schedule 40 (1.90 OD) pipe. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware, and accessories.
2. Assemble gate frames by welding or fittings and rivets for rigid connections. Use same fabric as for fence, unless otherwise indicated.
3. Install fabric with tension bars at vertical edges, and tie at top and bottom edges. Attach tension bars to gate frame with tension bands.
4. Attach hardware with rivets or by other means which will provide security against removal or breakage.
5. Provide diagonal cross-bracing consisting of 3/8 inch diameter adjustable length truss rods on gates where necessary to provide frame rigidity without sag or twist.

2. Hardware

1. Provide the following hardware and accessories for each gate; furnish heavy galvanized.
 - a. Hinges:

Pressed steel or malleable iron to suit gate size, nonlift-off type, offset to permit 180° gate opening. Provide 1 pair of hinges for each leaf.
 - b. Latch:

Forked type or plunger-bar type to permit operation from either side of gate. Provide padlock eye as integral part of latch.



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**SPECIFICATION FOR
CHAIN LINK FENCING**

2.0 **PRODUCTS** (continued)

c. Keeper:

Provide keeper for all vehicle gates which automatically engages the gate leaf and holds it in the open position until manually released.

2. Double Gates

Provide gate stops for all double gates consisting of mushroom type or flush plate with anchors. Set in concrete to engage the center drop rod or plunger bar. Provide locking device and padlock eyes as an integral part of the latch, requiring one padlock for locking both gate leaves.

3. Sliding Gates

Provide manufacturer's standard heavy-duty track, ball bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, and accessories.

4. All hardware shall be hot-dipped galvanized conforming to ASTM A153.

2.4 **Concrete**

A. Concrete consisting of Portland Cement shall comply with ASTM C150, aggregates shall comply with ASTM C33, and clean potable water shall be used. Mix materials to obtain concrete with a minimum 28-day compressive strength of 2500 psi, using at least 4 sacks of cement per cubic yard.

3.0 **EXECUTION**

3.1 The Contractor shall inspect the area to verify the following:

a. The fence line shall be cleared of all trees, stumps, and brush or accessible overhang within 5 feet of fence (or within property lines if closer than 5 feet to property line).



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**SPECIFICATION FOR
CHAIN LINK FENCING**

3.0 **EXECUTION** (continued)

- b. The area shall be cleared and fence line graded so that bottom of the fence fabric will be within 2 inches of the ground line, except at ditch crossings.

3.2 **Anchors**

- A. All posts shall be set in foundations or anchored the size and depth of which shall be as follows:
1. LINE POSTS 36" deep x 10" diameter or larger
 2. End Corner and 44" deep x 12" diameter or larger
PULL POSTS
 3. GATE POSTS Depth 14 times and diameter 4 times the nominal diameter of posts
- B. In all cases, the anchor shall extend at least 3 inches below the frost line.
- C. The post shall be set in fresh concrete so that 4 inches of concrete extends below the bottom of the post, plumbed in each direction, and braced adequately so as to remain in the correct position until after concrete has attained its final set. The top of the anchor shall be cone shaped to drain water away from the post, and shall stand approximately 1 inch above the ground line at the perimeter of the anchor.
- D. Keep exposed surfaces of concrete moistened. Allow concrete to attain at least 75% of its minimum 28 day compressive strength before tension wires, barbed wire, and fabric is installed. Gates shall not be hung until concrete has attained its full design strength.

3.3 **Ditch Crossing**

- A. Wherever the fence line crosses open ditches, the Contractor shall provide a sketch detailing the fence crossing to suit local circumstances and to conform with the following specification.



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SPECIFICATION FOR
CHAIN LINK FENCING

3.0 EXECUTION (continued)

1. The gap between the bottom of the fence fabric and the contour of the ditch shall be closed with barbed wire in parallel strands 6 inches on center.
2. The barbed wire shall be securely anchored in such a way that the bottom strand is within 2 inches of the contour of the ground.
3. Posts, as required, shall be not less than 2 inch iron pipe size, galvanized steel, and set in concrete anchors. The anchors shall conform to the specifications of paragraph 3.2 except that the top of the anchor shall be flush with the bottom of a normally dry ditch or not less than 1 inch above low water line when water is normally present.

B. Brace Assemblies

Install braces so posts are plumb when diagonal rod and fabric are under proper tension.

C. Tension Wire

Install tension wire(s) before stretching fabric, and tie to each post with ties or clips.

D. Fabric

Pull fabric taut and tie to posts, rails, and tension wire(s). Anchor fabric to framework so that fabric remains in tension after pulling force is released. When joining rolls of fabric their ends shall be patched and joined by a spiral connecting link. Install fabric on security side of fence.

E. Tension Bars

Thread through fabric and secure to posts with tension bands.



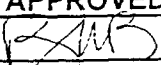

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SPECIFICATION FOR CHAIN LINK FENCING			
3.0 <u>EXECUTION</u> (continued)			
F. <u>Barbed Wire</u>			
Install 3 parallel wires on each 45° extension arm. Pull wire taut and fasten securely to each extension arm with tension bands. Refer to paragraph 2.1.0(3) for direction of extension arms.			
G. <u>Gates</u>			
Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.			
H. <u>Fasteners</u>			
Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.			
I. <u>Repair and Clean-Up</u>			
1. Repair damaged galvanized areas with Rustoleum's 7085 Cold Galvanizing Compound (Aerosol Spray) or approved equal.			
2. All excess fencing materials and other debris resulting from fence construction shall be collected and promptly removed from the site.			

DIVISION 3



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00			NO. 03200		
BY MHH			APPROVED 	ISSUE DATE 8/23/96	
SPECIFICATION FOR CONCRETE REINFORCEMENT					
THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.					
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OTIS ANGB, MA
JEG JOB NO. 35-K784-00

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**SPECIFICATION FOR
CONCRETE REINFORCEMENT**

1.0 **GENERAL**

1.1 **Description**

- A. This section describes the requirements for concrete reinforcement in concrete structures and foundations, as shown on the Drawings.

1.2 **Related Sections**

1. Section 03300 - Cast-In-Place Concrete
2. Section 03600 - Grouting

1.3 **Reference Standards** (Latest Edition)

1. ACI 318: Building Code Requirements for Reinforced Concrete
2. ANSI/ASTM A 185: Specifications for Welded Steel Wire Fabric for Concrete Reinforcement
3. ASTM A 615: Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

1.4 **Submittals**

1. Shop Drawings: Indicate bar sizes, spacing, locations, and quantities of reinforcing steel, bending, and cutting schedules and supporting and spacing devices.

1.5 **Quality Assurance**

1. Perform work in accordance with ACI 318.

2.0 **PRODUCTS**

- A. Reinforcing steel shall be made from deformed new billet stock and shall conform to ASTM A 615, Grade 60.
- B. Reinforcement chairs shall be non-corrosive.



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**SPECIFICATION FOR
CONCRETE REINFORCEMENT**

2.0 **PRODUCTS** (continued)

- C. All reinforcement shall be free from oil, mill scale and excessive rust or other coatings that will destroy or reduce bond.
- D. Welded Steel Wire Fabric: ASTM A 185 gages, spacing, and dimensions as shown on the Drawings.
- E. Tie Wire: Minimum 16 gage annealed type.
- F. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions (including load bearing pad on bottom to prevent vapor barrier puncture).
- G. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: (Plastic coated steel) type; size and shape as required.

3.0 **EXECUTION**

3.1 **Installation**

- A. Accurately form reinforcement to the dimensions indicated.
- B. Bend all bars cold. Do not straighten in a manner which will injure the material.
- C. Space and position bars as shown on the Drawings.
- D. Provide the following concrete protective covering for main reinforcement, unless noted:
 - 1. 3" for all concrete deposited directly against the ground, and for all concrete in liquid retaining structures.
 - 2. 2" for all formed concrete exposed to weather or in contact with the ground or water.
 - 3. 3/4" for concrete slabs and walls and 1-1/2" for beams and girders not exposed to weather nor in contact with the ground.
 - 4. 2" for columns in all cases (protective covering for spirals or ties shall be not less than 1-1/2" nor less than 1-1/2 times the maximum size of coarse aggregate).



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SPECIFICATION FOR
CONCRETE REINFORCEMENT

3.0 EXECUTION (continued)

5. Concrete protection shall always be at least equal to the diameter of the bars.
- E. Splice and tie reinforcement in accordance with the requirements of ACI 318, and shown on the Drawings.



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1.0 **GENERAL**

1.1 **Description**

This section describes the requirements to furnish all labor, material, tools, equipment, and supervision necessary for the construction of all plain and reinforced concrete work as called for on the project drawings and as specified herein.

1.2 **Related Sections**

1. Section 03200 - Concrete Reinforcement

2. Section 03600 - Grouting

1.3 **Reference Standards** (Latest Edition)

1. ACI 211: Recommended Practice for Selecting Proportions for Normal Weight Concrete

2. ACI 301: Structural Concrete for Buildings

3. ACI 302: Guide for Concrete Floor and Slab Construction

4. ACI 304: Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete

5. ACI 305R: Recommended Practice for Hot Weather Concreting

6. ACI 306R: Recommended Practice for Cold Weather Concreting

7. ACI 308: Standard Practice for Curing Concrete

8. ACI 347R: Guide for Formwork for Concrete

9. ACI 350: Concrete Sanitary Engineering Structures

10. ACI 504R: Guide to Sealing Joints in Concrete Structures

11. ASTM C 31: Standard Method of Making and Curing Concrete Test Specimens in the Field



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SPECIFICATION FOR CAST-IN-PLACE CONCRETE				
1.0	<u>GENERAL</u> (continued)			
	12.	ASTM C 33:	Specification for Concrete Aggregates	
	13.	ASTM C 39:	Test for Compressive Strength of Cylindrical Concrete Specimens	
	14.	ASTM C 94:	Specification for Ready-Mixed Concrete	
	15.	ASTM C 150:	Specification for Portland Cement	
	16.	ASTM C 172:	Sampling Fresh Concrete	
	17.	ASTM C 260:	Standard Specification for Air-Entraining Admixtures for Concrete	
	18.	ASTM C 330:	Specification for Lightweight Aggregate for Structural Concrete	
	19.	ASTM C 494:	Specification for Chemical Admixtures for Concrete	
	20.	ASTM C 948:	Test Method for Dry and Wet Bulk Density, Water Absorption and Apparent Porosity of Thin Sections of Glass Fiber Reinforced Concrete	
	21.	ASTM D 1751:	Specification for Pre-Formed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types)	
	22.	ASTM D 1752	Standard Specification for Pre-Formed Sponge Rubber and Cork Expansion Joint Filler for Concrete Paving and Structural Construction	
	23.	ASTM D 2103:	Specification for Polyethylene Film and Sheeting	
	24.	CRD C 572:	Corps of Engineers Specification for Poly (Vinyl Chloride) Water Stops	



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**SPECIFICATION FOR
CAST-IN-PLACE CONCRETE**

1.0 **GENERAL** (continued)

1.4 **Submittals**

A. **Design Mixes**

1. Submit design mixes and laboratory test reports indicating that the concrete ingredients and proportions will result in concrete mixes meeting requirements specified.

B. **Hot and Cold Weather Concreting**

1. Submit proposed methods for compliance with hot and cold weather requirements.

C. **Certificates**

1. Submit certificate stating that each admixture used is identical in composition to the sample used for acceptance testing and is compatible with all other materials in the design mix.

D. **Batch Tickets**

1. Submit delivery ticket from the concrete supplier with each batch delivered to the site, setting forth the following information:
 - a. Name and supplier
 - b. Name of batching plant and location
 - c. Date
 - d. Serial number of ticket
 - e. Truck number and batch number
 - f. Contract number and location
 - g. Volume of concrete (cubic yards)
 - h. Class of concrete (2500 psi, 3000 psi, or 4000 psi)



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

1.0 GENERAL (continued)

- i. Time loaded and amount of water added
- j. Type and brand of cement
- k. Weight of cement
- l. Maximum size of aggregate
- m. Weights of fine and coarse aggregates
- n. Types and amounts of admixtures

E. Working Drawings

- 1. Show details of form types, form ties, expansion joints, and construction joints.

1.5 Quality Assurance

- A. Perform work in accordance with ACI 301.
- B. Maintain one copy of all referenced standard documents on site.
- C. Acquire cement and aggregate from same source for all work.
- D. Conform to ACI 305R when concreting during hot weather.
- E. Conform to ACI 306R when concreting during cold weather.
- F. Conform to ACI 504R when installing joint sealer.
- G. Conform to ACI 302 when constructing floor slab.

1.6 Supplementary Requirements

This specification shall be supplemented by the following:

- A. Design drawings, which shall take precedence over this specification.



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**SPECIFICATION FOR
CAST-IN-PLACE CONCRETE**

1.0 GENERAL (continued)

B. Applicable technical standards as noted on the design drawings.

C. Local building code requirements.

2.0 PRODUCTS

2.1 Concrete Materials

A. Cement

Cement shall be Type II Portland Cement, conform to ASTM C150, unless otherwise specified.

B. Fine and Coarse Aggregate

1. Coarse aggregate shall be gravel or crushed stone, well graded from fine to coarse within prescribed limits, meeting the requirements of ASTM C33. Maximum nominal coarse aggregate shall be 1", except for mass or foundation concrete, maximum size shall be 1-1/2".

2. Fine aggregate shall be sand, clean, and sharp.

C. Water

Water used in mixing concrete shall be potable and free of injurious amounts of oils, acids, alkalies, sulfates, and other deleterious substances.

D. Aggregate for Lightweight Concrete

Where lightweight concrete is specified on the drawings, the aggregate shall conform to ASTM C 330.

2.2 Admixtures

Approval of the Engineer is required prior to use of admixtures.

A. Air Entrainment: ASTM C260

B. Chemical: ASTM C494



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

2.0 PRODUCTS (continued)

C. Fly Ash: ASTM C618, Class C

2.3 Accessories

A. Bonding Agent

1. Two component epoxy resin "Sonobond" as manufactured by Soneborn Building Products.
2. Two component liquid epoxy or paste "Concresive" as manufactured by Master Builders.

B. Vapor Barrier

Clear polyethylene film, not less than 10 mils thick, recommended for below grade application conforming to ASTM D2103.

C. Waterstops

Waterstops shall be either rubber or PVC material of the dumbbell or center bulb type, installed as shown on the drawing meeting Corps of Engineers Specification CRD-C572.

2.4 Joint Devices and Filler Materials

A. Joint Filler (For Interior or Exterior use)

Type "A": ASTM D 1751 asphalt impregnated fiberboard or felt, 1/2 inch thick, tongue and groove profile.

B. Joint Filler (For Interior use only)

Type "C": ASTM D 1752 premolded sponge rubber fully compressible with recovery rate of 95 percent.

C. Sealant

1. Polysulfide or Epoxy, chemical resistant sealer with minimum range of expansion - contraction of 25 percent.



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

2.0 PRODUCTS (continued)

2. Joint primer, backer rod and bond breaker tape, as specified by sealant manufacturer.

2.5 Concrete Mix

- A. Concrete for equipment foundations, paving and structural slabs shall have a minimum compressive strength of 3,000 psi in 28 days, unless design requirements warrant use of concrete with higher strength whereas the contract drawings will indicate minimum compressive strength requirements. The concrete shall be normal weight and proportioned in accordance with ACI 211.
- B. Concrete for liquid retaining structures shall have a minimum compressive strength of 4,000 psi in 28 days. The concrete shall be proportioned in accordance with ACI 211, subject to the following special requirements:
 1. Maximum Water-Cement Ratio: 0.45.
 2. Minimum Cement Content: 564 lbs. per cubic yard, unless otherwise specified.
 3. Air Content: 6 ± 1 percent.
 4. Slump: 1" minimum, 3" maximum for footing, 4" maximum for beams, slabs, and walls.
- C. Design mixes shall be based on the required over-design factor in ASTM C94, assuming a coefficient of variation equal to 15.
- D. Use accelerating admixtures in cold weather only when approved by Engineer. Use of admixtures will not relax cold weather placement requirements.
- E. Use of calcium chloride will not be permitted.
- F. Use set retarding admixtures during hot weather only when approved by Engineer.
- G. Add air entraining agent to normal weight concrete mix for work exposed to exterior.



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

2.0 PRODUCTS (continued)

- H. Concrete shall be placed at slumps in accordance with ACI 301, with the exception of concrete placed with super elasticizer.
- I. Concrete for electrical duct banks shall have a minimum 9 pounds of red oxide coloring agent added per cubic yard of concrete.

2.6 Formwork

- A. The design and construction of the formwork shall be in accordance with the recommendation of ACI 347R.
- B. Provide forms for all concrete. Do not use earth cuts for vertical surfaces except when indicated.
- C. External corners of structures and foundations above grade shall be formed with one inch chamfer, unless otherwise noted.
- D. Forms for beam and girder sides, column and similar vertical structural members may be removed after 24 hours, provided the concrete is sufficiently hard.
- E. Supporting forms or shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction load, but in no case shall they be removed in less than 7 days.

3.0 EXECUTION

3.1 Examination

- A. Verify site conditions.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete, are accurately placed, positioned securely, and will not cause hardship in placing concrete.



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

3.0 EXECUTION (continued)

3.2 Preparation

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
- B. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels, and pack solid with non-shrink grout or epoxy grout as shown on the drawing per manufacturer instruction.

3.3 Placing Concrete

- A. Conform to the requirements of ACI 304, Chapter 6, except concrete for liquid retaining structures shall be placed according to the requirements of ACI 350, Chapter 4.
- B. Concrete sections more than 3 feet in the least dimension are termed mass concrete and shall conform to the special provision of ACI 301, Chapter 14, in addition to all applicable provisions specified.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and anchor bolts are not disturbed during concrete placement.
- D. Install vapor barrier under interior slabs on grade. Lap joints minimum 6 inches and seal watertight by sealant applied between overlapping edges and ends.
- E. Repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier material; lap over damaged areas minimum 6 inches and seal watertight.
- F. Separate slabs on grade from vertical surfaces with 1/2 inch thick joint filler.
- G. Install joint devices in accordance with manufacturer's instructions.



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

3.0 EXECUTION (continued)

- H. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- I. Apply sealants in joint devices in accordance with manufacturer instructions and ACI 504R.
- J. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- K. Place concrete continuously between predetermined expansion, control, and construction joints.
- L. Do not interrupt successive placement; do not permit cold joints to occur.

3.4 Separate Floor Toppings

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
- B. Place required dividers edge strips, reinforcing and other items to be cast in.
- C. Apply bonding agent to substrate in accordance with manufacturer's instructions.

3.5 Concrete Finishing

- A. Finish concrete surfaces in accordance with ACI 301.
- B. Wood float surfaces which will receive quarry tile ceramic tile terrazzo with full bed setting system.
- C. Steel trowel floor surfaces which will receive carpeting, resilient flooring, seamless flooring thin set quarry tile, thin set ceramic tile.
- D. Broom finish surfaces which are scheduled to be exposed.
- E. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains as indicated on drawings.



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

3.0 EXECUTION (continued)

- F. Area paving and sidewalks shall receive a broom finish.

3.6 Curing and Protection

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Cure concrete in accordance with ACI 308.
- D. Cure floor slabs using one of the following methods:
1. Ponding: Maintain 100 percent coverage of water over floor slab areas continuously for 4 days.
 2. Spraying: Spray water over floor slab areas and maintain wet for 7 days.

3.7 Field Quality Control

- A. Field inspection and testing will be performed in accordance with ACI 301.
- B. Provide free access to work and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of work.
- D. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.
- E. Three concrete test cylinders will be taken for every 75 cy or less of each class of concrete placed in one day.
- F. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.



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SPECIFICATION FOR
CAST-IN-PLACE CONCRETE

3.0 EXECUTION (continued)

- G. One slump test will be taken for each set of test cylinders taken.

3.8 Patching

- A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.
- C. Patch imperfections as directed in accordance with ACI 301.

3.9 Defective Concrete

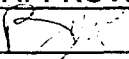

- A. Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Engineer.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00				NO. 03600	
				SPECIFICATION FOR GROUTING	
BY	APPROVED	ISSUE DATE			
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1.0 GENERAL

1.1 Description

This specification along with the drawings covers the furnishing of all material, equipment, accessories, tools, services, transportation, labor and supervision required for grouting. Application of grout types shall be as follows:

A. Drypack Grout

Use under low load requirements such as small base plates for building columns, and pipe supports.

B. Cement-Based Nonshrink Grout

Use under heavy load requirements such as highly loaded column bases, anchor bolts and dowels, and ordinary equipment not subject to severe dynamic loads and vibratory conditions.

C. Nonshrink Epoxy Grout

Use under equipment which is subject to severe dynamic loads and vibratory conditions such as heavy crane rails, boilers, turbines, turbogenerators, extruders and heavy compressors. Epoxy grouting should also be used in areas where oil, solvent, or acid could degrade the grout.

Work Included:

a. Concrete surface preparation

b. Furnishing and installation of all leveling plates

c. Furnishing and installation of all grout

1.2 Related Sections

1. Section 03200 Concrete reinforcement

2. Section 03300 Cast-in-place concrete



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SPECIFICATION FOR GROUTING

1.0 GENERAL (continued)

1.3 References Standards (Latest Edition)

1. ASTM C33 Specifications for Concrete Aggregates
2. ASTM C109 Standard Test Method for Compressive Strength of Hydraulic-Cement Mortars (using 2 in. or 50 mm cube specimens).
3. ASTM C150 Specifications for Portland Cement
4. ASTM C230 Standard Specifications for Flow Table in Tests of Hydraulic Cement
5. ASTM C531 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing.
6. ASTM C579 Standard Test Method For Compressive Strength Of Chemical-Resistant Mortars, Grouts
7. ASTM C827 Standard Test Method For Change In Heights At Early Ages of Cylindrical Specimens from Cementious Mixtures
8. ASTM C1090 Test Method for Measuring Change in Height of Cylindrical Specimens from Hydraulic-Cement Grout
9. ASTM C1107 Standard Specification for packaged Dry, Hydraulic Cement Grout (Nonshrink).
10. ASTM C1181 Standard Test Method of Compressive Creep of Chemical-Resistant Polymer Machinery Grouts

1.4 Submittals

- A. Contractor shall submit printed instructions accompanying nonshrink grout and epoxy grout containers.
- B. The grout supplier shall submit copies of laboratory test reports, including all test data certifying that the selected products will produce grouts of qualities specified herein.



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SPECIFICATION FOR GROUTING

1.0 GENERAL (continued)

1.5 Product Delivery, Storage, and Handling

- A. Nonshrink grout material shall be stored and handled in accordance with the manufacturer's printed instructions.
- B. Cement-based grouting materials which have become damp or air-set shall not be used.
- C. Nonshrink cement-based grout and epoxy grout aggregate shall be delivered to the job site in sound, dry bags. Epoxy grout hardener and resin shall be delivered in sealed containers. The contractor shall be responsible for storing the grout in a dry, weatherproof shelter.

2.0 PRODUCTS

A. Drypack Grout

- 1. Drypack shall be a mixture of one part cement and 2-1/2 parts sand by volume proportioned at the job site and mixed thoroughly with just enough water to produce a consistency such that when a sample is tightly squeezed in the hand only enough moisture will come to the surface to moisten the hand.
- 2. Portland cement shall conform to ASTM C150, Type I.
- 3. Sand shall conform to ASTM C33.

B. Cement-based Nonshrink Grout

- 1. Nonshrink Cementitious Grout shall be a preportioned product packaged according to ASTM C1107 requiring only the addition of potable water and shall not contain metallic substances or aluminum powder.



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SPECIFICATION FOR GROUTING

2.0 PRODUCTS (continued)

2. Performance Characteristics

Cement-based nonshrink grout shall meet the following requirements:

- a. Dimensional Stability/Compressive Strength - The Grout shall meet the requirements of ASTM C1107 Grade C, when prepared according to manufacturer's instructions and tested at 40°F and 90°F (5°C and 3°C).
- b. Placeability - The grout shall be capable of maintaining at least a flowable consistency for a minimum of 45 minutes at 70°F (21°C) measured under ASTM C230, using 5 drops in 3 seconds.
- c. Mixing Water - Water shall be clean and free of oils, acids, alkalis, organics and other deleterious materials.

3. Manufacturers

The following manufacturers supplies material which meet this specification.

MANUFACTURER

Five Star Products, Inc.

Master builder

PRODUCTS

Five Star Grout
Five Star Grout 100
Five Star Instant Grout

Master Flow 928

C. Nonshrink Epoxy Grout

1. Nonshrink epoxy grout shall be a preproportioned, factory packaged product consisting of specially formulated resin, hardener and aggregate.



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SPECIFICATION FOR GROUTING

2.0 PRODUCTS (continued)

2. Performance Characteristics

- a. Epoxy Grout shall have a minimum compressive strength of 5,000 psi at 24 hours and 15,000 psi at 7 days when tested according to ASTM C579 (Method B).
- b. The grout shall show no shrinkage (0.0%) and a maximum of 2.5% expansion at all ages when tested in accordance with ASTM C827 (modified). The volume change test for epoxy group, ASTM C82 (modified), requires an indicator ball with a specific gravity of between 0.9 and 1.1.
- c. The length change after hardening shall be negligible (Less than 6.0×10^{-4} in/in or mm/mm when tested according to ASTM C531.
- d. The grout shall be capable of maintaining at least a flowable consistency for a minimum of 45 minutes at 70 °F (21°C).
- e. The coefficient of thermal expansion shall be less than 3.0×10^{-3} in/in/°F (60°C) according to ASTM C531.
- f. The compressive creep at one year shall not exceed 1.0×10^{-3} in/in° F (mm/mm) when tested under a 400 psi constant load at 140°F (60°C) according to ASTM C1181.

3. Manufacturers

The following manufacturers supply material which meet this specification

MANUFACTURER

PRODUCTS

Five Star Products, Inc.

Five Star Epoxy Grout
Five Star #F Epoxy Grout

Master Builder

Celicote 648 CP Plus



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SPECIFICATION FOR GROUTING

2.0 PRODUCTS (continued)

Other manufacturers may submit materials to the Design Engineer for approval following the procedures outlined in Article 1.4.

3.0 EXECUTION

3.1 Mixing

A. Drypack Grout

Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 to 5 minutes. Batches shall be sized to allow continuous placement of freshly mixed drypack.

Drypack grout not used within one hour after mixing shall be discarded. Retempering will not be allowed.

B. Cement-based Nonshrink Grout

1. Cement-based grout shall be mixed in a wheelbarrow or mortar mixer with moving paddles inside a drum, not in a concrete mixer with fins attached to a rotating drum.
2. All mixing equipment shall be free of oil, grease or other foreign substances. The mixer shall be washed out and excess water poured out before mixing any grout. Before mixing a batch of grout, any remaining from preceding batch shall be washed out. Retempering of leftover grout is not allowed.
3. Mixing shall be adjacent to the area being grouted. Sufficient manpower and equipment shall be available for rapid and continuous mixing and placing. Mix materials for 3-5 minutes and place immediately.
4. Grout shall not be mixed in quantities larger than that which can be placed during the working time specified herein.



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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

C. Nonshrink Epoxy Grout

1. All epoxy grout components shall be conditioned to a temperature between 70°F and 80°F prior to mixing. The entire hardener component shall then be added to the resin component and thoroughly mixed for 2 to 3 minutes with a low speed mixer. Mixed resin and hardener shall then be put into a clean mortar mixer or wheelbarrow and the entire bag of aggregate added. Mix until aggregate is completely wetted. Nothing else shall be added to the mixture.
2. Mixing shall be adjacent to area being grouted, with sufficient manpower and equipment available for rapid and continuous mixing and placing.
3. Grout shall not be mixed in quantities larger than that which can be placed during the working time specified herein.

3.2 General Grouting Requirements

A. Work Prior to Setting Base Plates or Equipment

1. Concrete foundations shall be at least 14 days old prior to grouting.
2. Concrete surfaces shall be prepared for grouting or dry-packing by chipping back to sound concrete. The surface shall be clean, with all laitance, grease, oil, dirt or loosened aggregate removed prior to setting leveling plates.
3. Water for surface soaking, mixing and curing cement-based grout or drypack shall be potable.
4. Set all leveling plates to the proper elevation. The number and type of leveling plates will be as shown on the drawings or determined by the Engineer in accordance with the recommendations of the equipment manufacturer and other project documents.



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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

- Concrete surfaces on which cement-based grout or drypack is to be placed shall be thoroughly soaked with water for 24 hours. Just prior to grouting, the water shall be removed from anchor bolt sleeves.
- Concrete surfaces on which epoxy grout is to be placed shall be completely dry before grouting.
- Metal surfaces in contact with the grout or drypack shall be clean and free of oil and grease, and other foreign substances. The presence of tightly bonded paint is not objectionable.
- Prior to pouring grout, debris material in anchor bolt sleeve shall be removed.

B. Grout Formwork

- Formwork shall be provided for grout and shall be compatible with the method of placing grout specified herein.
- Forms shall be designed for rapid, continuous and complete filling of space to be grouted. Forms shall be of adequate strength to withstand the horizontal forces of the fluid grout, and shall be caulked or sealed with tape to prevent leakage. The forms shall be coated with form oil or heavy wax to prevent grout adherence and absorption.
- Forms shall not be butted against a base plate or equipment base but shall allow at least 1 inch of space all around. The top of the forms shall be level with the bottom of the base plate. Forms shall have a chamfer strip attached where a chamfered edge is required.



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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

3.3 Placing

A. Drypack Grout

1. The space between the top of the concrete bearing surface and the bottom of the base plate shall be filled with drypack grout by ramming the grout in place with bar or 2 x 4 until the space is completely filled.
2. When placing drypack grout, the temperature of the foundation, base plate and drypack grout shall be within the temperature range of 40°F to 90°F as determined by surface thermometer. Maintain this temperature range for 3 days following grouting.

B. Cement-based Nonshrink Grout

1. Cement-based grout has a limited working time after mixing. This working time is specified herein. At least 45 minutes working time is recommended to avoid rushing the grout placement and frequent cleaning of equipment. The placing of grout shall be performed only during this specified working time and any unused grout beyond this time shall be discarded. Place the grout quickly and continuously to avoid segregation, bleeding or premature initial set.
2. When placing cement-based grout, the temperature of the foundation, base plate and grout material shall be within 40°F to 90°F and maintained at this temperature for 3 days following grouting.



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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

3. Cement-based grout shall be placed from one long side of an equipment base to the other, in one direction only. The grout shall be poured into a movable head box having an inclined plane to direct the grout beneath the equipment base in a manner which minimizes trapped air and bubble formation. The head box should be about a 3 foot cube to allow large volumes of grout to be poured continuously. Alternatively, construct a fixed slanted form extending about 12 inches above the foundation top along the pour side. The use of vibrators is not permitted. The use of steel straps is permitted to move grout into position but chaining is not permitted because of air entrapment between the links.
4. Pumping grout is permitted and may eliminate the requirement for a head box.
5. Grout placing shall be continued until it oozes out along the entire perimeter and up through every interior air relief hole and grout hole. An exception occurs when grouting such equipment as pumps having an elevated interior base plate. In these situations, fill under the entire equipment base to the top of the exterior base plate and then stop grouting for a short period of time to allow the grout to seal the periphery. Complete the grouting through one of the interior grout holes.
6. Vibration from nearby operations can be transmitted into the foundation of the structure being grouted. It can cause bleeding, settlement, affect setting time, strength or create a hidden fracture plane. Vibration can be detected by observing the surface of a shallow pan of water set on the structure to be grouted. The Construction Manager shall determine if vibration from nearby operations warrants shutdown of such operations until grout has taken its final set.

C. Nonshrink Epoxy Grout

1. Epoxy grout has a limited working time after mixing. A minimum of 30 minutes working time is recommended. The placing of grout shall be performed only during this specified working time and any unused grout remaining beyond this time shall be discarded.



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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

2. When placing epoxy grout, the temperature of the foundation, base plate and grout material shall be within 40°F to 90°F.
3. Epoxy grout shall be placed from one long side of an equipment base to the other, in one direction only. The grout shall be poured into a movable head box having an inclined plane to direct the grout beneath the equipment base in a manner which minimizes trapped air and bubble formation. The head box should be about a 3 foot cube to allow large volumes of grout to be poured continuously. The use of vibrators is not permitted. The use of steel straps is permitted to move grout into position but chaining is not permitted because of air entrapment between the links.
4. Pumping epoxy grout is permitted and may eliminate the requirement for a head box.
5. Epoxy grout placing shall be continued until it oozes out along the entire perimeter and up through every interior air relief hole and grout hole. An exception occurs when grouting such equipment as pumps having an elevated interior base plate. In these situations, fill under the entire equipment base to the top of the exterior base plate and then stop grouting for a short period of time to allow the grout to seal the periphery and then complete the grouting through one of the interior grout holes.
6. Expansion joints shall be installed as indicated on the design drawings or on 4' centers, whichever is closer for epoxy grout placements of long length or large area.

3.4 Finishing and Curing

A. Drypack Grout

Curing shall be by applying one coat of curing compound or by other approved curing procedure.



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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

B. Cement-based Nonshrink Grout

1. Finishing and curing shall be in strict accordance with the manufacturer's printed instructions.
2. Cement-based grout shall be protected from extreme drying conditions by covering all exposed grout surfaces with continually wetted burlap, rags, or waterproof paper for a minimum of 3 days following grouting.
3. Grout shall be maintained above 40° F (5°C) for a minimum of three days or above 70° F (21° C) for a minimum of 24 hours to avoid damage from subsequent freezing.

C. Nonshrink Epoxy Grout

1. Finishing and curing shall be in strict accordance with the manufacturer's printed instructions.
2. Epoxies cannot be trimmed after set. They must be left at the finished level with required chamfer strips built into the forms. Top surfaces may be trowelled with a steel trowel moistened with oil. Further finishing will require grinding.
3. The epoxy grout shall be maintained within the placing temperature range for a minimum of 24 hours after placing.
4. Do not wet-cure epoxy grout.

3.5 Technical Services

1. For nonshrink cement based and non-shrink epoxy grouts, a manufacturer's technical representative shall be called to the field office for a pregrouting conference to assure that all grouting steps are followed in accordance with the manufacturer's instructions.
2. The representative shall remain at the job site until the Construction Manager is assured that the correct procedures are being followed and that the warranty is not in jeopardy.



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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SPECIFICATION FOR GROUTING

3.0 EXECUTION (continued)

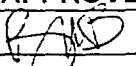

3. If the manufacturer's representative recommends anything contrary to this specification, the Construction Manager shall advise the Design Engineer.

DIVISION 4




Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00				NO. 04300	
BY XN		APPROVED 		ISSUE DATE 10/2/96	
SPECIFICATION FOR CONCRETE UNIT MASONRY					
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 04300	PAGE 1 OF 16
BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR CONCRETE UNIT MASONRY	
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1.0 **GENERAL**

1.1 **Description**

A. This section describes the requirements for concrete unit masonry as shown on the drawings.

Section Includes

- Concrete Block Walls - Load and Non-Load Bearing Walls
- Partition Walls, Cavity, or Chase Walls
- Engineered Masonry Walls
- Reinforcement, Anchorage, and Accessories

B. **Product Installed but not Furnished**

- Placement of Fabricated Steel Items
- Placement of Reglets and Sheet Metal Flashings

1.2 **Related Sections**

A.	Section 03200	Concrete Reinforcement
B.	Section 03300	Cast-In-Place Concrete
C.	Section 09901	Architectural Painting
D.	Section 10800	Toilet and Bath Accessories



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

1.0 **GENERAL** (continued)

1.3 **Quality Assurance**

A. **Allowable Tolerances**

1. Maximum variation from plumb in lines and surfaces of walls:
 - a. 1/4 inch in 10 feet
 - b. 1/2 inch maximum per floor
 - c. 1 inch maximum total height
2. Maximum variation of linear building line from an established position in plan and related portions of all walls:
 - a. 1/4 inch in 10 feet
 - b. 1/2 inch maximum

1.4 **Reference Standards** (Latest Edition)

1. ACI 530-1 Specification for Masonry Structures
2. ASTM A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
3. ASTM A116 Specification for Zinc-Coated (Galvanized) Iron or Steel Farm-Field and Railroad Right-of-Way Wire Fencing
4. ASTM A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM C90 Specification for Hollow Load-Bearing Concrete Masonry Units
6. ASTM C144 Specification for Aggregate for Masonry Mortar
7. ASTM C207 Specification for Hydrated Lime for Masonry Purposes
8. ASTM C150 Specification for Portland Cement



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

1.0 **GENERAL** (continued)

9. ASTM C270 Specification for Mortar for Unit Masonry

10. ASTM C129 Non-Load Bearing Concrete Masonry Units

11. ASTM A615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement

12. ASTM A145 Solid Load Bearing Concrete Masonry Units

13. ASTM D226 Standard Specification for Asphalt Saturated Organic Felt used in Roofing and Waterproofing

14. ASTM D1056 Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

15. ASTM D2000 Standard Classification System for Rubber Products in Automotive Application

16. IMCA International Masonry Industry, All Weather Council - Recommended Practices and Guide Specifications for Cold Weather masonry Construction

17. UL Underwriters Laboratories

1.5 **Submittals**

A. **Brochures or Catalog Cuts**

1. Joint Reinforcement & Fabricated Wire Reinforcement

2. Control Joint Materials

3. Admixtures

B. **Samples**

1. Show extreme variations in color and texture.

2. Concrete Masonry Units: Four individual full size samples



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

1.0 **GENERAL** (continued)

C. **Certificates**

1. Submit manufacturer's certificates attesting compliance with applicable specifications for grades, types or classes specified.

2. Submit manufacturer's installation instructions.

1.6 **Qualifications**

Installer: Company specializing in performing the work of this section shall have minimum five years documented experience.

1.7 **Regulatory Requirements**

Conform to UL Assembly No. for the requirement of fire rated masonry construction.

1.8 **Mock-Up**

Erect 8'-0" long x 4'-0" high sample panel demonstrating standard of construction including specified mortar and accessories. Maintain sample panel until project completion then destroy and remove.

1.9 **Delivery, Storage, and Handling**

A. Store masonry units under cover in a manner that permits circulation of air and prevents intrusion of foreign matter or excess water absorption.

B. Protect reinforcement from elements. Clean to remove loose runs and other coatings, including ice, immediately prior to placement.

C. Store cement and lime in dry areas, watertight sheds with elevated floors. Store sand off the ground; keep dry and under cover. Storage temperature for cement shall be above 35°F.

D. Handle concrete masonry units and lintel blocks so that edges and faces are not chipped, spilled or cracked. Damaged materials exposed in the finished work will not be acceptable.



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SPECIFICATION FOR
CONCRETE UNIT MASONRY

1.0 GENERAL (continued)

1.10 Environmental Requirements

1. Cold Weather Preparation:

- a. Remove frozen or damaged masonry.
- b. Use dry masonry units.
- c. Maintain mortar or grout temperatures between 70°F and 110°F.

2. Cold Weather Installation:

- a. Air temperatures 40°F to 32°F:

Mortar: Heat mixing water to a minimum of 40°F and a maximum of 120°F.

3. Completed Masonry in Cold Weather:

- a. Mean daily temperature 48°F to 32°F: Protect masonry from rain or snow by covering with non-staining weather-resistive membrane.
- b. Follow "IMCA" recommended practices and specifications for Cold Weather masonry.

4. Hot Weather Installation:

- a. Protect masonry construction from direct exposure to wind and sun when erected in an ambient temperature greater than 90°F in the shade with Relative Humidity less than 50 percent. Keep mortar temperatures below 120°F to avoid flash set.

5. Completed Masonry in Hot Weather:

- a. Air temperature above 90°F.

Apply a very light fog spray several times during the first 24 hour period.



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

2.0 **PRODUCTS**

2.1 **Materials**

A. **Hollow Concrete Masonry Units**

1. ASTM C90. Nominal face dimensions 8 inch x 16 inch, Grade N, Type I, normal weight. For above and below grade exterior wall applications.
2. Provide all special shapes required such as 90° corners, bullnosed corners, sash, jambs, lintels, bands, bond beams, and cover base.
3. "UL" Label Concrete Block Masonry Units: Units shall meet the fire rating indicated on the drawing. Units shall comply with ASTM C90. Units must receive Underwriters' Laboratory Assembly Approval.

B. **Mortar Materials**

1. Portland Cement: ASTM C150, Type II.
2. Hydrated Lime: ASTM C207, Type S.
3. Sand: ASTM C144, except provided within the following limits:

<u>SIEVE SIZE</u>	<u>PERCENT PASSING</u>
No. 4	100
No. 8	95 to 100
No. 16	60 to 100
No. 30	35 to 70
No. 50	15 to 35
No. 100	2 to 15
No. 200	0 to 2
4. Water shall be clean, potable and free from injurious amounts of oil, acid, alkalies, organic materials or other deleterious materials.



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

2.0 PRODUCTS (continued)

5. Admixtures: Use one of the following or approved equal:

a. Master Builders "Omicron", Toch Brothers, "Toxement IW", Sonneborn "Hydrocide". Follow manufacturer's instructions.

C. Joint Reinforcement, Anchors, and Ties

1. Coating meeting or exceeding applicable standards:

a. Zinc-coating flat metal: ASTM A153, Class B2.

b. Zinc-coating wire: ASTM A116, Class 3.

2. Single-Wythe Reinforcement: (Horizontal)

a. Wire diameter: Side rods 3/16 inch deformed; cross ties, and shall conform to ASTM A82.

b. Shape: Truss Type.

c. Size: Width suitable for wall thickness, length flat sections 10 ft. or more.

d. Fabricated sections for corners and intersections of walls.

3. Column Anchors

AA Wire Products Company, "Flex-O-Lok" or approved equal weld-on 1/4 inch steel anchor rod 9 inches long with 3/8 inch offset and 4 inch adjustment used with 3/16 inch galvanized triangular wire tie sized to fit construction conditions.

4. Wall Reinforcement

Reinforcement shall conform to "Specifications for Deformed and Plain Billet Steel" for concrete reinforcement (ASTM A615) Grade 60 steel.



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

2.0 PRODUCTS (continued)

5. Strap Anchors

Anchors shall be 1-1/2" wide x 3/16" thick x 12" long, spaced at 16" o.c. welded to structural steel columns as shown on the drawing.

D. Accessories

1. Preformed Control Joints

Joints shall be "Dur-O-Wal" Rapid Control Joint - Rubber Compound conforming to ASTM D-2000, or approved equal. Locations as shown on the drawing.

2. Expansion Joint

Expansion Joint shall be "Dur-O-Wal" "Rapid Soft Joint/Expansion Joint", closed cell neoprene material conforming to ASTM D1056, Class RE41, or approved equal.

3. Building Paper

#15 asphalt saturated felt conforming to ASTM D226.

4. Nailing Strips: Western soft wood, preservative treated for moisture resistant, dovetail shapes sized to masonry joints.

5. Weep Holes

Preformed plastic tubes standard 3/8" O.D. x 4" long by "Dur-O-Wal".

6. Cleaning Solutions

Non-acidic, not harmful to masonry work or adjacent materials. Use "101 Lime Solvent" by Process Solvent Company Inc. or approved equal in strict accordance with manufacturer's instructions.



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

2.0 PRODUCTS (continued)

7. Precast Concrete Splash Blocks

Furnish and install precast concrete splash blocks as shown on the drawings conforming to requirements of the American Concrete Institute including minimum compressive strength of 3,000 psi at 28 days.

E. Grout

1. Grout shall be proportioned by volume measurements. It should have a minimum strength of 3000 psi at 28 days.
2. Fine grout should be one part portland cement, 2-1/4 to 3 parts sand to which may be added 1/10 part hydrated lime or lime putty. Fine grout is used in narrow grout spaces.
3. Coarse grout includes pea gravel and is used for hollow units and wide (2 inches or more) grout spaces. It should be one part portland cement, 2 to 3 parts sand, and not more than 2 parts pea gravel to which may be added 1/10 part hydrated lime or lime putty.

F. Mortar Mixing

1. Type "M" Mortar (2500 psi), ASTM C270 for all work. Machine-mix all mortar in approved mechanical mixer. (When scope of work is small, hand mixing is permitted). Measure materials by consistent method, either by volume or by weight in accurate manner. Measurement of sand by shovel shall not be permitted. Mix not less than five minutes; two minutes for mixing the dry materials and not less than three minutes for mixing after the water has been added. Introduce admixture in accordance with manufacturer's directions.

G. Retempering

Use and place in final position all mortars within two and one-half hours after initial mixing.



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

3.0 **EXECUTION**

3.1 **Examination**

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Verify items provided by other sections of work are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.
- D. Beginning of installation means installer accepts existing conditions.

3.2 **Preparation**

- A. Direct and coordinate placement of metal anchors supplied to other sections.
- B. provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracings.

3.3 **Coursing**

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimensions. Form vertical and horizontal joints of uniform thickness.
- C. Lay concrete masonry units in running bond. Course one unit and one mortar joint to equal 8 inches. Form concave mortar joints.

3.4 **Placing and Bonding**

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.



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SPECIFICATION FOR CONCRETE UNIT MASONRY			
3.0 <u>EXECUTION</u> (continued)			
C. Remove excess mortar as work progresses.			
D. Interlock intersections and external corners.			
E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.			
F. Perform jobsite cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners and edges.			
H. Cut mortar joints flush where ceramic or quarry tile, resilient base is scheduled. Cavity insulation vapor barrier adhesive or bitumen damp-proofing is applied.			
I. Isolate masonry partitions from vertical structural framing members with a control joint as indicated on the drawing.			
J. Isolate top joint of masonry partitions from horizontal structural framing members and slab or decks with compressible joint filler.			
3.5 <u>Reinforcement and Anchorages</u>			
A. Install horizontal joint reinforcement (Standard Truss Type reinforcement at 16 inches O.C. unless otherwise shown on the drawings).			
B. Place masonry joint reinforcement in first horizontal joints above and below openings. Extend minimum 16 inches each side of opening.			
C. Place joint reinforcement continuous in first joint below top of walls.			
D. Lap joint reinforcement ends and extend each side of openings as shown on the drawings.			
E. Support and secure reinforcing bars from displacement. Maintain position with 1/2 inch of dimensional position.			



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

3.0 **EXECUTION** (continued)

 F. Embed anchors attached to structural steel members in every second block.

3.6 **Masonry Flashings**

 A. Extend flashing over lintels, under parapet-cap and turn up or down 8 inches and embed into mortar joint of masonry.

 B. Lap end joints minimum 6 inches and seal watertight.

 C. Use flashing manufacturer's recommended adhesive and sealer.

3.7 **Lintels**

 A. Install loose steel, precast concrete block lintel units over window, door, HVAC Duct, electrical bus or cable tray openings and bank of pipes openings.

 B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.

 C. Install reinforcing steel for lintel reinforcement as shown on the drawings.

 D. Use single piece reinforcing bars only.

 E. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

 F. Place and consolidate grout fill without displacing reinforcing.

 G. Allow masonry lintels to attain specified strength before removing temporary supports.

 H. Maintain minimum 8 inches bearing on each side of opening.

3.8 **Grouted Components**

 A. Reinforce bond beam with reinforcing steel as shown on the drawings.



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

3.0 **EXECUTION** (continued)

- B. Reinforce pilasters with reinforcing steel as shown on the drawing.
- C. Lap splices minimum 24 bar diameters.
- D. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- E. Place and consolidate grout fill without displacing reinforcing.
- F. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.9 **Engineered Masonry**

- A. Lay masonry units with core cells vertically aligned clear of mortar and unobstructed.
- B. Place mortar in masonry unit bed joints back 1/4 inch from edge of unit grout spaces, bevel back and upward. Permit mortar to cure 7 days before placing grout.
- C. Reinforce masonry unit cores with reinforcement bars and grout as indicated.
- D. Retain vertical reinforcement in position at top and bottom of cells and at intervals shown on the drawings. Splice reinforcement in accordance with Section 03200.
- E. Wet masonry unit surfaces in contact with grout just prior to grout placement.
- F. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques. Grout spaces 2 inches or greater in width with coarse grout using high or low lift grouting techniques.



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SPECIFICATION FOR CONCRETE UNIT MASONRY			
3.0 <u>EXECUTION</u> (continued)			
G. When grouting is stopped for more than one hour, terminate grout 1-1/2 inch below top of upper masonry unit to form a positive key for subsequent grout placement.			
H. Low Lift Grouting: Place first lift of grout to a height of 16 inches and rod for grout consolidation. Place subsequent lifts in 8 inch increments and rod for grout consolidation.			
I. High Lift Grouting:			
1. Provide cleanout opening no less than 4 inches high at the bottom of each cell to be grouted by cutting one face shell of masonry unit.			
2. In double wythe walls, omit every second masonry unit in one of the widths for clean out and cell inspection purposes.			
3. In double wythe walls, construct vertical grout barriers or dams between the masonry widths with masonry units every 30 feet maximum.			
4. Clean out masonry cells and cavities with high pressure water spray. Permit complete water drainage.			
5. Request inspection of the cells and cavities. Allow 3 days advance notice of inspection.			
6. After cleaning and cell inspection, seal openings with masonry units.			
7. Pump grout into spaces. Maintain water content in grout to intended slump without aggregate segregation.			
8. Limit grout lift to 60 inches and rod for grout consolidation. Wait 30 to 60 minutes before placing next lift.			



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**SPECIFICATION FOR
CONCRETE UNIT MASONRY**

3.0 **EXECUTION** (continued)

3.10 **Control and Expansion Joints**

- A. Do not continue horizontal joint reinforcement through control and expansion joint.
- B. Install preformed control joint device and expansion joint device in continuous length. Seal butt and corner joints in accordance with manufacturer's instruction.

3.11 **Built-In Work**

- A. As work progresses, build in metal door and glazed frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates and other items furnished by other sections.
- B. Built-in items shall be plumb and level.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build-in organic materials subject to deterioration.

3.12 **Cutting and Fitting**

- A. Cut and fit for chases, pipes, conduit, sleeves. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain Architect/Engineer approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.13 **Parging**

- A. Dampen masonry walls prior to parging.
- B. Scarify each parging coat to ensure full bond to subsequent coat.
- C. Parge masonry walls in two uniform coats of mortar to a total thickness of 2 inch.



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SPECIFICATION FOR CONCRETE UNIT MASONRY			
3.0 <u>EXECUTION</u> (continued)			
D. Steel trowel surface smooth and flat with a maximum surface variation of 1/8 inch per foot.			
3.14 <u>Protection of Work</u>			
A. Protect sills, ledges, and offsets from mortar drippings or other damage during construction. Remove misplaced mortar or grout immediately. Protect face materials against straining. Protect door jambs and corners from damage during construction.			
B. Without damaging completed work, provide protective boards at exposed external corners which may be damaged by construction activities.			
3.15 <u>Pointing and Cleaning</u>			
A. Cut out any defective joints and holes in exposed masonry and repoint with mortar.			
B. Dry brush masonry surface after mortar has set at end of each days work and after final pointing.			
C. Clean exposed masonry with cleaning agent.			
D. Protect metal lintels and other materials which may corrode when masonry is cleaned with cleaning agent.			

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DIVISION 5



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K784-00


NO. 05120

SPECIFICATION FOR
STRUCTURAL STEEL

BY	APPROVED	ISSUE DATE
MHH		8/23/96

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00					NO. 05120	PAGE 1 OF 8
					SPECIFICATION FOR STRUCTURAL STEEL	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
MHH		8/23/96	0	8/23/96		

1.0 GENERAL

1.1 Description

A. This specification includes furnishing all labor, material, equipment and accessories necessary for the fabrication and erection of the structural steel work as called for on the project drawings.

1.2 Related Sections

A. Section 05310 Steel Decking

1.3 Reference Standards (Latest Edition)

1. ASTM A36 Structural Steel
2. ASTM A53 Hot-Dipped, Zinc-Coated Welded and Seamless Steel Pipe
3. ASTM A108 Steel Bars, Carbon, Cold-Finished, Standard Quality
4. ASTM A123 Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
5. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. ASTM A307 Carbon Steel Externally Threaded Standard Fasteners
7. ASTM A325 High-Strength Bolts for Structural Steel Joints
8. ASTM A490 Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
9. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes
10. ASTM A501 Hot-Formed Welded and Seamless Carbon Steel Structural Tubing



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**SPECIFICATION FOR
STRUCTURAL STEEL**

1.0 GENERAL (continued)

- 11. ASTM F436 Hardened Steel Washers
- 12. ASTM A563 Specification for Carbon and Alloy Steel Nuts
- 13. ASTM F959 Compressible - Washers - Type Direct Tension Indicators For Use With Structural Fasteners
- 14. AWS A2.0 Standard Welding Symbols
- 15. AWS D1.1 Structural Welding Code
- 16. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Building
- 17. SSPC Steel Structures Painting Council

1.4 Submittals

- A. Manufacturer's Data
 - 1. Submit Manufacturer's Mill Certificate indicating that the product meets or exceeds specified requirements.
 - 2. Submit Mill Test Report indicating structural strength, destructive and non-destructive test analysis.
- B. Welders Certificate
 - 1. Submit welders' certificates indicating welders employed on the work, verifying AWS qualification within the previous 12 months.
- C. Shop Drawings
 - 1. Submit shop drawings, including complete details and schedule for fabrication and shop assembly of members.
 - 2. Include details of cuts, connections, cambers, holes and other pertinent data. Indicate welds by standard AWS symbols and show size, length and type of each weld.



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**SPECIFICATION FOR
STRUCTURAL STEEL**

1.0 **GENERAL** (continued)

1.5 **Quality Assurance**

- A. Fabricate structural steel members in accordance with AISC - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
- B. Maintain one copy of each document onsite.

1.6 **Qualifications**

A. **Fabricator**

Company specializing in performing the work of this section with minimum 5 years documented experience.

B. **Erector**

Company specializing in performing the work of this section with minimum 5 years documented experience.

- C. Design connections not detailed on the drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the state where the project is located.

2.0 **PRODUCTS**

A. **Structural Steel**

- 1. All structural steel shall be made by open hearth, basic oxygen, or electric furnace processes. Steel shall conform to ASTM A36, except structural steel pipe which shall conform to ASTM A53, Grade B, and shall be galvanized according to ASTM A123 after fabrication, unless otherwise specified on the drawings.

B. **Structural Bolts, Nuts, and Washers**

- 1. Standard bolts shall conform to ASTM A307. Nuts shall be heavy hexagon nuts, conforming to ASTM A563. Washer shall conform to ASTM F436.



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SPECIFICATION FOR STRUCTURAL STEEL			
2.0 <u>PRODUCTS</u> (continued)			
2. All high-strength bolts shall conform to ASTM A325, Type 1. Each bolt assembly shall include the following:			
a. One heavy hexagon nut (unless drawings indicate double nuts) conforming to ASTM A563, Grade DH.			
b. One high-strength washer conforming to ASTM F436.			
c. One load indicator washer as licensed by Cooper and Turner.			
3. Bolts, nuts and washers shall be galvanized in accordance with ASTM A153.			
4. Bolts 3/4" and larger shall be high-strength bolts conforming to ASTM A325, Type 1. Bolts smaller than 3/4" shall conform to ASTM A307, Grade B, and may be used for girts, handrails, ladders and cages.			
C. <u>Welding Electrodes</u>			
1. Welding electrodes shall conform to AWS D1.1 and be of proper classification for condition of use.			
D. <u>Anchor Bolts and Nuts</u>			
1. Anchor bolts shall conform to ASTM A307 or A36, as indicated on design drawings. Nuts shall be heavy hexagon nuts, conforming to ASTM A563. Washers shall conform to ASTM F436.			
2. Bolts, nuts and washers shall be galvanized in accordance with ASTM A153.			
E. <u>Grating</u>			
1. Grating shall be steel, hot-dip galvanized and of all welded construction with serrated edges. Grating size shall be 1-1/4" x 3/16", unless otherwise specified on the drawings.			
2. Grating shall be attached with saddle-type hold-down clips engaging two main bearing bars. Clips shall be secured to supporting member with self-tapping, thread cutting, hex-head screws, with washer (ASTM A-320, Grade B8). Self-drilling and tapping screws (410 stainless steel) as manufactured by Buildex, or equal also acceptable.			



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**SPECIFICATION FOR
STRUCTURAL STEEL**

2.0 **PRODUCTS** (continued)

F. **Checkered Plate**

1. Checkered plate shall be 1/4" thick and galvanized, unless noted on the drawings.
2. Checkered plate shall be attached with 3/8" diameter flat-head machine bolts in 7/16" diameter countersunk holes spaced on 2'-0" maximum centers, unless noted on the drawings. Holes in floor plate to be shop drilled. Holes in supporting steel to be field drilled.

G. **Steel Tubing**

1. Cold steel tubing conforming to ASTM A500, Grade B.
2. Hot-formed steel tubing conforming to ASTM 501.

H. **Shop and Touch-up Primer**

1. SSPC 15, Type 1 red oxide primer for structural steel to be painted, not galvanized.
2. SSPC 20, Type 1, inorganic zinc rich primer for galvanized surfaces.

I. **Stair Treads**

1. Stair treads shall be 1-1/4" x 3/16" serrated grating with checkered plate nosing.

3.0 **EXECUTION**

3.1 **Fabrication**

- A. Contractor shall prepare complete fabrication drawings including erection diagrams, shop details and bills of material. Fabrication drawings shall be submitted to the Contracting Officer for approval before fabrication commences.
- B. When neither reactions nor connection details for beams are shown on the drawings, connections for such beams shall be designed for loads as specified in Part 4 of the AISC Manual of Steel Construction.



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SPECIFICATION FOR STRUCTURAL STEEL			
3.0 <u>EXECUTION (continued)</u>			
<p>C. Designation "M.C." on the drawings denotes moment connections. All moment connections shall develop full moment capacity of member, unless noted.</p> <p>D. Shop connections shall be welded, unless noted. Field connections shall be bolted with 3/4" diameter ASTM A325 bolts, unless noted.</p> <p>E. Welding shall be done in accordance with latest edition of the Structural Welding Code AWS D1.1 of the American Welding Society.</p> <p>F. Detailing and fabrication of all structural steel shall be performed in accordance with the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.</p> <p>G. The Engineer shall be allowed free access at all times to the fabrication shop to inspect the fabrication of structural members and to witness tests.</p> <p>H. All shop welded connections shall be seal welded.</p> <p>I. Steel stencil all piece marks.</p> <p>J. High-strength bolted connections shall be designed as bearing type connections with threads included in the shear plane, unless drawings indicate "slip critical" whereas reduced allowable bolt stresses and prepared contact surfaces shall be in accordance with AISC.</p> <p>K. All bolt holes shall be 1/16" diameter greater than the bolt diameter, unless otherwise noted on drawing.</p> <p>L. Vertical diagonal bracing connections not detailed on design drawings shall be detailed by the fabricator to develop the full-strength of the number of bolts or load specified on the drawings. Where no bolts or loads are specified, the fabricator shall detail connections for the full tension capacity of the member. End gusset plates for diagonal bracing shall connect directly to main members in the plane of the bracing.</p> <p>M. Double angle members shall have welded fillers spaced in accordance with Section E4 of the AISC Specification.</p>			



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3.0 EXECUTION (continued) SPECIFICATION FOR STRUCTURAL STEEL

- N. Long single-angle bracing members shall be fabricated with a draw. The actual computed distance between end holes shall be reduced as follows:

<u>Length</u>	<u>Reduction</u>
0 to 10'	None
Over 10' to 20"	1/16"
Over 20' to 35' 1/8"	
Over 35'	3/16"

- O. Columns shall be finished for full bearing at splices and at end plates, except when full penetration welds are specified on design drawings.
- P. Grating shall be shop cut and banded at all columns, bracing, posts, gusset plates, penetrations and any other locations indicated on drawings.
- Q. Gusset plates shall be a minimum of 3/8" thick.
- R. Splicing of structural steel members where not detailed on the drawings is prohibited without prior approval of the Engineer.
- S. It shall be the Fabricator's responsibility to see that the galvanized steel is delivered to the jobsite in a nonwarped and undistorted condition.
- T. Horizontal diagonal bracing shall have a minimum of two bolt connections where no bolts or loads are shown on the design drawings.

3.2 Erection

- A. Erection shall be in accordance with latest edition of AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and shall include the setting of all columns, beams, trusses, grating and handrails, and the erection and complete installation of all other structural steel to true line, grade and plumbness.



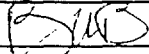

DATE 8/23/96	REV NO. 0	NO: 05120	PAGE 8 OF 8
SPECIFICATION FOR STRUCTURAL STEEL			
<p>3.0 <u>EXECUTION (continued)</u></p> <p>B. Structural steel shall be plumbed with suitable guy wires and held in plumb during field welding. Guy wires shall be placed so as not to interfere with the necessary work.</p> <p>C. Steel shall not be placed or erected on concrete foundations or floor slabs until the concrete has cured a minimum of seven (7) days.</p> <p>D. Drifting, other than light drifting necessary to draw the holes together, will not be permitted.</p> <p>E. Cutting of flanges, webs, or angles will not be permitted without prior approval from the Engineer.</p> <p>F. Galvanized coating damaged by handling, cutting, burning, welding, or drilling shall be repaired with zinc rich coating.</p> <p>G. Holes shall not be made or enlarged by burning. Fabrication errors shall not be corrected by burning members. Holes shall be cut by drilling or punching and deburred only. Method of correction of fabrication errors is subject to the approval of the Owner.</p> <p>H. Surfaces in contact shall be thoroughly clean at the time of assembly.</p> <p>I. High-strength bolts employing load indicator washers shall be installed, tightened and inspected in accordance with ASTM F959.</p> <p>J. Machine bolts and shoulder bolts of ASTM A307 material shall be installed "snug tight" and shall have one washer used with each bolt.</p> <p>3.3 <u>Grouting</u></p> <p>A. All bearing plates shall be set to proper grade and level before grouting.</p>			

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Jacobs Engineering Group, Inc.
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00				NO. 05310	
				SPECIFICATION FOR METAL DECK	
BY	APPROVED	ISSUE DATE			
MH		8/23/96			
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BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR METAL DECK	
MH		08/23/96	0	8/23/96		

1.0 GENERAL

1.1 Description

This section describes the requirements for metal decking of buildings, as shown on the drawings.

1.2 Related Sections

1. Section 05120 Structural Steel

1.3 Quality Assurance

A. Qualifications of Fabricator

Decking shall be fabricated by a firm whose roof deck sections have been designed in accordance with SDI Specifications. Each deck section shall have a design certification from SDI.

B. Qualifications of Welders

Welders shall be qualified in conformance with Section 5, Qualification, of AWS D1.1.

1.4 Reference Standards (latest edition)

A. AWS D1.1: Structural Welding Code

B. Steel Deck Institute (SDI) Design Manual for Floor Decks and Roof Decks

C. ASTM A 36: Specification for Structural Steel

D. ASTM A 446: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

E. MIL-P-20135: (Ships) Paint, High-Zinc Dust Content, Galvanizing Repair

F. ASTM A 525: Steel Sheet, Zinc-Coated, Galvanized by Hot-Dip Process



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**SPECIFICATION FOR
METAL DECK**

1.0 **GENERAL** (continued)

1.5 **Submittals**

- A. Submit shop drawings showing layout of deck panels, anchorage details and every condition requiring closure panels, supplementary framing, special jointing or other accessories.
- B. Product data: Provide deck profile characteristics and dimensions, structural properties and finishes.
- C. Manufacturer's installation instructions.

2.0 **PRODUCTS**

2.1 **Materials**

- A. Steel Sheet: ASTM A 446, Grade A, with G115 Galvanized Coating, ASTM A 525.
- B. Miscellaneous Steel Shapes: ASTM A 36, Galvanized.
- C. Flute Closures: Closed-cell foam rubber, one inch thick, profiled to fit tight to the decking.

2.2 **Fabrication**

- A. Form deck units in lengths to span three or more supports with flush, telescoped or nested two inch end-laps and nesting side-laps, unless otherwise shown.
- B. Decking shall be of Wide Rib (WR) configuration as specified in the SDI Manual, unless otherwise shown. Rib depth and metal gauge shall be as shown on the project drawings.
- C. Fabricate metal closure strips of not less than 20 gauge galvanized sheet steel of the same quality as the deck units. Form to the configuration required to provide tight-fitting closures at open ends and sides of decking.



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SPECIFICATION FOR
METAL DECK

3.0 EXECUTION

3.1 Installation

A. General

Install deck units and accessories in accordance with manufacturer's recommendations and approved shop drawings, and as specified herein.

B. Placing Deck Units

1. Place deck units on supporting steel framework and adjust to final position with ends bearing on supporting members with minimum four inch bearing and accurately aligned end to end before being permanently fastened. Lap ends not less than two inches. Do not stretch or contract the side-lap interlocks. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
2. Do not use deck units for storage or working platforms until permanently secured.

C. Fastening Deck Units

1. Permanently fasten deck units to steel supporting members by not less than 3/4 inch diameter fusion welds, or elongated welds of equal strength, not less than 12 inches on center at supports and at closer spacing where required for lateral force resistance.

Use welded washers where recommended by deck manufacturer.
2. Comply with requirements and procedures of AWS D1.1 for manual shielded metal-arc welding, the appearance and quality of welds and the methods used in correcting welding work.
3. Lock side-laps between adjacent deck units at intervals not exceeding 24 inches on center by tack-welding, button-punching, or mechanical fasteners. Weld side-laps.



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SPECIFICATION FOR METAL DECK			
3.0 <u>EXECUTION</u> (continued)			
D. <u>Cutting and Fitting</u>			
Cut and fit roof deck units and accessories around other work projecting through or adjacent to the roof decking, as shown. Provide neat, square, and trim cuts.			
E. <u>Reinforcement at Openings</u>			
Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work, unless otherwise shown.			
F. <u>Closure Strips</u>			
1. Provide metal closure strips at all open uncovered ends and edges of roof decking, and in the voids between decking and other construction. Weld into position to provide a complete decking installation.			
2. Install double raw edge of foam flute closures above walls and portions perpendicular to deck flutes.			
G. <u>Roof Insulation Support</u>			
Provide metal closure strips for the support of roof insulation where the rib openings in the top surface of roof decking occur adjacent to edges and openings. Weld closure strips into position.			
H. <u>Galvanizing Touch-Up</u>			
Touch-up damaged galvanized top and bottom surfaces of decking units with galvanizing repair paint in accordance with MIL-P-20135. Prior to repairing galvanized surfaces damaged by welding, blast clean or otherwise treat welds to remove slag completely.			

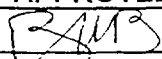

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DIVISION 7



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00			NO. 07210		
			SPECIFICATION FOR BUILDING INSULATION		
BY	APPROVED	ISSUE DATE			
MH		8/23/96			
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BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR BUILDING INSULATION	
MH	<i>[Signature]</i>	08/23/96	0	8/23/96		

1.0 GENERAL

1.1 Description

A. This section describes the requirements for wall and roofing insulation in buildings and where indicated on drawings.

B. This section does not cover insulation for pre-engineered building.

1.2 Related Sections

A. Section (09250) Gypsum Wall Board

1.3 Quality Assurance

A. Reference Standards

1. ASTM C665 Standard Specification for mineral fiber blanket thermal insulation for light frame construction and manufactured housing

2. ASTM E84: Standard Test for Surface Burning Characteristic of Building Materials.

1.4 Submittals

A. Manufacturer's product literature, including installation instructions and fire performance characteristics.

1.5 Product Delivery, Storage and Handling

A. Insulation materials shall be completely protected while in storage and during application, to keep them dry at all times.

1.6 Job Conditions

A. Environmental Requirements

Work shall not proceed in rain or on a wet deck. Wet insulation shall be discarded and replaced with dry insulation of same manufacturer, type and thickness.



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SPECIFICATION FOR BUILDING INSULATION

2.0 PRODUCTS

2.1 Batt/Blanket Insulation (Wall/Roof)

A. Batt Insulation: ASTM C665; preformed glass fiber batt blanket, friction fit, conforming to the following:

1. Thermal Resistance: R of 10 per one inch nominal thickness.
2. Facing: (As shown on the drawings)
 - Mesh reinforced kraft paper
 - Aluminum foil facing
3. Flame/Smoke Properties: 25/40 in accordance with ASTM E84.

B. Sheet Vapor Retarder: Black polyethylene film reinforced with glass square mesh, 6 mil.

D. Tape: Bright aluminum, self-adhering type, mesh reinforced, two (2) inch wide.

E. Insulation Fasteners: Steel impale spindle and clip on flat metal base, self adhering backing, length to suit insulation thickness, capable of securely and rigidly fastening insulation in place.

F. Wire Mesh: Galvanized steel, hexagonal wire mesh, 20 gauge minimum.

2.2 Acceptable Manufacturer

A. Batt/Blanket Insulation

1. Owens-Corning Fiberglass Corp.
2. Schuller International Inc.



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SPECIFICATION FOR BUILDING INSULATION

3.0 EXECUTION

3.1 Examination

Verify substrate surface is flat, free of honeycomb, fins, irregularities, materials or substances that may impede adhesive bond.

Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.

3.2 Installation for BATT Insulation

- A. Install insulation and vapor retarder in accordance with manufacturer's.
- B. Install in walls, roof and ceiling spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation.
- E. Faced Insulation
 - 1. Install with factory applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane between framing members.
 - 2. Staple or nail facing flanges in place at maximum (6) inches.
 - 3. Tape seal butt ends, lapped flanges and tears or cuts in membrane.
- F. Provide supplemental support where needed using wire mesh securely fastened to prevent sagging of insulation.



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SPECIFICATION FOR BUILDING INSULATION

3.0 EXECUTION (insulation)

G. Membrane Vapor Retarder

1. Wood framing: Place vapor retarder on warm side of insulation by stapling or nailing at (6) inches. Lap and seal sheet retarder joints over member face.
2. Metal framing: Place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.

3.3 Protection of Finished Work

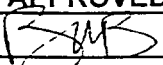

- A. Protect all finished work.
- B. Do not permit work to be damaged prior to covering insulation.

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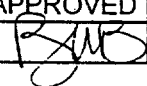


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Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00				NO. 07900	
				SPECIFICATION FOR SEALANT AND CAULKING	
BY	APPROVED	ISSUE DATE			
MH		8/23/96			
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					SPECIFICATION FOR SEALANT AND CAULKING	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
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1.0 **GENERAL**

1.1 **Description**

A. This section describes the requirements for sealants and caulking as shown on the drawings.

1.2 **Related Sections**

A. Section (08330) Coiling Doors

B. Section (09250) Gypsum Board System

C. Section (09310) Ceramic Tile

1.3 **Quality Assurance**

A. **Reference Standards** (Latest Edition)

1. FS-TT-S-0227E: Sealing Compound Elastomeric Type, Multi-Component (For Caulking, Sealing and Glazing in Buildings and Other Structures).

2. FS-TT-S-0023C: Sealing Compound Elastomeric Type, Single Component (For Caulking, Sealing and Glazing in Buildings and Other Structures).

3. ASTM D412: Tension Testing of Vulcanized Rubber.

4. ASTM D2240: Indentation Hardness of Rubber and Plastics by Means of Durometer.



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SPECIFICATION FOR
SEALANT AND CAULKING

1.0 GENERAL (continued)

1.4 Submittals

A. Certificates of Compliance

1. Caulking Compound
2. Sealing Compound

B. Color Range Samples

1. Caulking Compound
2. Sealing Compound
3. Samples of Material including Primer

C. Product Data Sheets

1.5 Product Delivery, Storage and Handling

A. Labeling and Delivery of Sealing and Caulking Materials

Sealant and caulking containers shall be labeled and delivered to the site in the original, unopened containers. Containers which have been opened or damaged prior to use shall be removed from the site.

B. Storage of Materials

Materials shall be stored and handled so as to prevent inclusion of foreign matter and water or deteriorating effect of hot or cold temperatures.

1.6 Job Conditions

A. Environmental Requirements

Sealing and caulking compounds shall not be applied when prevailing temperature of joint surface is below 50 degrees F. or in damp or rainy weather.



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**SPECIFICATION FOR
SEALANT AND CAULKING**

1.0 **GENERAL** (continued)

B. Joint Width and Substrate Conditions

Do not proceed with installation of joint sealants where joint widths are more or less than allowed by manufacturer, or where contaminants interfering with sealant adhesion are present.

2.0 **PRODUCTS**

2.1 Materials

A. Sealing compound shall be two-part, gun-grade, non-sag polysulfide in color as required to match adjacent work. Sealing compound shall conform to Federal Specification TT-S-0227E. Sealing compound shall be used for sealing all joints on the building exterior and for control joints on interior.

B. Caulking compound shall be one-part, 100 percent liquid polymer sealant formulated for sealing interior joints in building construction, except as otherwise specified. Caulking compound shall possess excellent qualities of adhesion to porous and non-porous surfaces, resistance to hardening, cohesive strength, freedom from migration (bleeding) and resistance to dilute acids and alkaline solutions. Caulking compound shall conform to Federal Specification TT-S-0023C, 10aGP-5b.

C. Joint back-up shall be polybutene sponge rubber (non-staining, premolded resilient type) as recommended by sealing and caulking manufacturer. Back-up filler shall be non-staining, premolded resilient material such as rope yard, neoprene or butyl rod, polyurethane or other closed cell foam with compressible characteristics. Width or diameter of uncompressed filler material shall be at least 1-1/3 times the width of the joints to be caulked or sealed. Filler material shall not adhere to the caulking compound or sealant used and shall be provided with a bond breaker if the material has no releasing property. Bond breaker shall be strips of aluminum foil, polyethylene or other approved release material.

D. Primer shall be quick-drying, non-staining type of a consistency as recommended in caulking compound and sealant manufacturer's publication.



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**SPECIFICATION FOR
SEALANT AND CAULKING**

2.0 PRODUCTS (continued)

E. Sealants and caulking compounds shall be waterproof, elastic, self-leveling for horizontal application, non-sagging for vertical application and adherent to the surfaces on which they are applied. The material shall be non-staining, non-corrosive, non-bituminous and non-bleeding. The exposed surface of sealants and caulking compounds shall be in color approved by owner or suitable to receive paint to be used on adjacent surfaces.

1. Remain elastic for a period of at least 5 years.
2. Peeling strength of at least 10 pounds per inch of width, when peeled gradually from concrete surface after curing for seven days.
3. Ultimate tensile strength of 100 psi minimum at 250 percent elongation in accordance with ASTM D412.
4. No indication of cracking when temperature reaches 20°F.
5. Stability, no indication of sagging when temperature reaches 180°F.
6. Hardness, Shore A scale, between (20 and 35) points in accordance with ASTM D2240.

F. Sealants shall be one of the following as approved:

1. Two component polysulfide base synthetic rubber compound, a product bearing Thiokol Chemical Corporation's "Tested and Approved" seal, such as "Sonolastic Two-Part Sealant" by Sonneborn Building Products, Inc. "Dymeric" by Tremco, "PRC Caulk 500" by Products Research & Chemical Corporation or "Synthacaulk" by Pecora Corporation.

The material shall conform to Thiokol's Building Trade Performance Specifications.

2. One-component silicone rubber base compound with 100 percent solids, such as "Dow Corning 790 or 791" by Dow Corning Corporation, "G.E. Silicone 1300 Sealant" by General Electric Co. or "SWS-940" by Stauffer Wacker Silicone Corporation.



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**SPECIFICATION FOR
SEALANT AND CAULKING**

2.0 PRODUCTS (continued)

3. One or two-component polyurethane compound, such as "Eternaflex Non-Sag Urethane" by Gibson-Homans Company, "Rubber Caulk 3105" by Products Research Chemical Corporation or "Polytek Sealant" by Toch Brothers Division of Carboline Company.

G. Caulking compound shall be used for general caulking at non-working joints where little or no movement is anticipated. Compound shall be one of the following as approved:

1. One-component acrylic compound, such as "60 Unicrylic" by Pecora Corporation "Acrilast 570" by Toch Brothers Division of Carboline Company, or "Acrylic Sealant" by Dap, Inc.

2. One-component butyl rubber compound, such as "Butyl Flex" by Dap Inc. "Butyl Rubber" by DeWitt Products Co., "Butakauk" by Sonneborn Building Products, Inc., "Butyl Caulk" by Gibson-Homans Company or "Butyl Sealant BC158" by Pecora.

3.0 EXECUTION

3.1 Preparation

A. Preparation of Surfaces

1. Joints and spaces to be filled with sealant or caulking shall be dry, free from rust, loose paint, oil and grease, or other contaminants. Joints and spaces to be sealed or caulked shall be cleaned with compressed air.

2. Metal surfaces shall be cleaned with a solvent. Provide proper preparation of surfaces as recommended by manufacturer.

B. Joints and spaces to be filled with sealant greater in depth than the width of the joint, shall be packed with joint back-up material specified, so that the depth of the joint shall be not less than half the width nor more than equal to the width of the joint. The depth of the joint shall not be less than 3/8 inch.



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SPECIFICATION FOR
SEALANT AND CAULKING

3.0 EXECUTION (continued)

Packing shall provide a firm back-up for the sealant. Bond breaker shall be provided on the back surface of all joints to prevent the sealant from bonding to the back surface of the joint or to the back-up.

- C. Joints and spaces caulked shall be not more than 3/8 inch wide by 3/8 inch deep. Maximum size of the joints caulked shall be as recommended by the manufacturer. Joints more than 3/8 inch in depth shall be packed with joint back-up as specified.

3.2 Installation

- A. Completely seal with caulking and sealing compounds all joints, spaces, and connections as indicated, Manufacturer's printed instructions shall be strictly followed.
1. Application of sealing and caulking compounds shall be with manufacturer approved caulking guns, using proper size nozzles for the joint being filled.
 2. Grooves shall be prepared and cleaned to the depth and width required. Joint surfaces shall be sound, dry and clean immediately before filling. Porous joint material shall be primed as approved by the manufacturer. Sealing and caulking compounds shall thoroughly bond to the joint surfaces. Sealing compounds shall not bond to the back surface of joint.
 3. Sealing and caulking compound shall be applied with sufficient pressure to solidly fill the joint. Mask adjacent surfaces with masking tape prior to priming caulking. Remove tape after joint has been tooled. All joints to be filled shall be neatly tooled to a slight concave surface.
 4. Joints that do not meet the above requirements shall be corrected and resealed at no additional cost to the Owner.

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DIVISION 8



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO.: 35-K784-00

NO. 08110

SPECIFICATION FOR
METAL DOORS AND FRAMES

BY	APPROVED	ISSUE DATE
MH	<i>BUB</i>	8/23/96

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					SPECIFICATION FOR METAL DOORS AND FRAMES	
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1.0 GENERAL

1.1 Description

A. This section describes the requirements for metal doors and frames and metal fixed glass frames as shown on the drawings.

1.2 Related Sections

A. Section (08710) Finish Hardware

B. Section (07900) Sealant and Caulking

C. Section (08800) Glazing

D. Section (09250) Gypsum Board System

E. Section (09901) Architectural Painting

1.3 Quality Assurance

A. Requirements of Regulatory Agencies

Hollow metal doors and frames indicated to have UL labels shall be constructed in accordance with the requirements of the Underwriters Laboratories Inc. for the class opening indicated, and shall be standard frame units where practical. Labels will be provided on doors and frames.

B. Reference Standards (Latest Edition)

1. Underwriters Laboratories Inc., "Building Material Directory".

2. NFPA Pamphlet No. 80.

3. ANSI A115: Specification for door and frame preparation for Mortise door locks for 1-3/4" doors.



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**SPECIFICATION FOR
METAL DOORS AND FRAMES**

1.0 GENERAL (continued)

4.	ASTM C236:	Standard test method for steady state thermal performance of building assemblies by means of guarded hot box.
5.	ASTM E413:	Classification for rating sound insulation.
6.	ASTM E152:	Standard method of fire test of door assemblies.
7.	ASTM E90:	Standard test method of laboratory measurement of airborne sound transmission of building partitions.
8.	ANSI SDI 117:	Manufacturing tolerance for standard steel doors and frames.

1.4 Submittals

A. Shop Drawings

1.	<u>Product Data</u>	Submit manufacturer's specifications for fabrication and installation, including data substantiating that products comply with requirements.
2.	<u>Shop Drawings</u>	<p>Submit for fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.</p> <p>Provide shop drawings for installation of glazing.</p> <p>Provide schedule of doors and frames, using same reference numbers for details and openings as those on contract drawings.</p>



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**SPECIFICATION FOR
METAL DOORS AND FRAMES**

1.0 **GENERAL** (continued)

B. Certificate of Compliance

"Label Constructed" doors and frames, and fixed glass frames. Fire window frames shall bear visible label "Fire Window Frame." (per NFPA 80, Ch. 13).

1.5 Product Delivery, Storage and Handling

A. Delivery

Deliver material in manufacturer's original, unopened and undamaged packages. Clearly identify manufacturer, brand name, contents, color, stock number and order number on each package. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage

Store in original packaging under protective cover and protect from damage. Stack containers in accordance with manufacturer's recommendations.

C. Handling

Handle materials in such a manner as to prevent damage to products or finish.

1.6 Warranty

A. Provide manufacturer's standard warranty on all doors and frames. (Regular and fire doors and fire rated metal fixed glass frames.)

2.0 **PRODUCTS**

2.1 Manufacturers:

Subject to compliance with requirements, provide products of one of the following:



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**SPECIFICATION FOR
METAL DOORS AND FRAMES**

2.0 **PRODUCTS** (continued)

A. Metal Doors and Frames:

1. Steelcraft Manufacturing Co.
2. Fenestra
3. Amweld
4. Ceco
5. Pioneer Industries
6. Republic Builders Products

2.2. **Metal Doors**

- A. Flush construction, 1-3/4 inch thick of types indicated.
- B. Face sheet shall be bonderized sheets of not less than 16 gauge for exterior door and 18 gauge for interior doors, cold rolled stretcher leveled steel. Exterior doors shall be galvanized.
- C. Core of doors shall have continuous interlocking steel stiffeners spaced not over 16 inches on center and be filled with mineral rock wool or other approved material. Joints in edges of doors shall be arc welded and ground smooth. Top edges of exterior doors shall have metal caps to provide flush top surfaces.
- D. **Thermal-Rated (Insulating) Assemblies**
- At exterior locations and elsewhere as shown or scheduled, provide doors which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236.
- E. **Rabbeted or Specially Prepared Openings**
1. Openings shall be provided for glazed panels or louvers where indicated.
 2. Glazing beads, where required, shall be secured with oval-head screws spaced not more than 6 inches on center and shall be 18 gauge, spaced to accommodate 1/4 inch glass, unless otherwise indicated. All glazing shall be done from the interior side for doors and windows.



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**SPECIFICATION FOR
METAL DOORS AND FRAMES**

2.0 PRODUCTS (continued)

3. Louvers shall be automatic, sight proof, stationary and formed of minimum 20 gauge steel, unless otherwise indicated. The entire louver assembly shall be fastened to the door with mouldings at the factory. For fire rated doors with louvers, the door shall be installed and manufactured in accordance with "NFPA 80" and Underwriters Laboratories Inc. "Building Material Directory", and shall be tested as a unit.

2.3 Frames

- A. Metal frames shall be provided for metal or wood doors and metal frames for fixed glass (fixed windows) as indicated. Frames shall have jamb widths and depths of the size and configuration indicated on drawings. Frames shall be of 16 gauge steel for interior doors and 14 gauge galvanized steel for exterior doors, and 14 gauge for metal frames for fixed glass.
- B. Frames shall have adjustable anchors and special anchors suitable for the materials in which the frames are to be installed. Anchors shall be provided for attachment to the floor with provision for vertical adjustment. One anchor shall be provided for each 30 inches of jamb height. Cover boxes shall be provided at hardware cutouts.
- C. Provide holes in frames for door silencers; 3 for single doors and 2 per leaf for pairs of doors, for interior doors.
- D. Frames for exterior doors shall be provided with formed drip at the heads on exterior face, applied with stainless steel screws. Provide factory-installed spreader bars for all welded door frame assemblies.
- E. Windows: Provide stops for 1/4" glass as scheduled.
- F. Door frames and frame extensions shall be designed to replace structurally the covering and framing displaced, using 30 PSF wind load.

2.4 Glazing

- A. Door vision panels shall have Type 1, Class 1, Quality q3, fully tempered clear float glass, single-lite, wet or gasket glazed, with interior removeable stops. Wired glass (type II) where required for fire rating. See Section 08800.



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**SPECIFICATION FOR
METAL DOORS AND FRAMES**

2.0 **PRODUCTS** (continued)

- B. Fixed glass panels see Glass and Glazing Section 08800.

2.5 **Fabrication**

- A. Necessary closures, filler members, reinforcing, and appurtenant members and accessories shall be provided. Surfaces shall be smooth and free from warps and buckles. Miters shall be neatly made with tight joints.

- B. Fabricate doors to comply with ANSI/SDI-117.

- C. **Shop Prime Coat**

Metal doors and frames shall be thoroughly cleaned of all oil, grease, rust and other foreign material, and sanded smooth. A rust inhibitive, baked-on shop primer shall then be applied.

2.6 **Preparation**

- A. **Hardware Reinforcing and Mortising**

Doors and frames shall be mortised, reinforced, drilled and tapped to receive finish hardware complying with applicable requirements of ANSI-A115. Hinge and lock reinforcements shall be securely welded to door and frames and shall be drilled and tapped to receive finish hardware.

3.0 **EXECUTION**

3.1 **Installation**

- A. **Installation of Frames**

1. Exercise care in setting frames to maintain scheduled dimensions, hold head level and maintain jambs plumb and square.
2. Secure anchorages and connections to adjacent construction per manufacturer's instructions. Allow for expansion movement as required.



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**SPECIFICATION FOR
METAL DOORS AND FRAMES**

3.0 **EXECUTION** (continued)

3. Leave frame spreader bars intact until frames are set square and plumb, and anchors are securely attached.

B. Installation of Doors

1. Apply hardware and install doors in accordance with hardware manufacturer's templates and door manufacturer's instructions.
2. Adjust operable parts for correct function and smooth operation.
3. Maintain alignment with adjacent work. Secure assembly to framed openings plumb and square without distortion or warp.
4. Installation of labeled doors and frames shall conform to NFPA Pamphlet No. 80 and all local codes and ordinances having jurisdiction.
5. Leave door units closed.

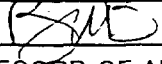

3.2 Cleaning and Patching

- A. All marred, dented and abraded surfaces shall be repaired after installation as approved. Defective materials shall be rejected and replaced with new materials at no additional cost to the owner.
- B. Clean doors, frames, and glass in accordance with manufacturer's instructions. Remove temporary labels and visible markings.



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SPECIFICATION FOR
COILING DOORS

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1.0 GENERAL

1.1 Description

- A. This section describes the requirements for the manufacture and installation of coiling doors where shown on the drawings.

1.2 Related Sections

- A. Section (07900) Sealants and Caulkings
B. Section (08710) Finish and Hardware
C. Section (09901) Architectural Painting
D. Section (13121) Pre-Engineered Building

1.3 Quality Assurance

A. Qualifications of Manufacturer

Provide the products of an established manufacturer who has been regularly engaged in the production of coiling doors and whose products have operated successfully.

1.4 Reference Standards (Latest Edition)

- A. ASTM A525 - Steel sheet, zinc coated (galvanized) by hot-dip process.

1.5 Design Criteria

- A. Design coiling doors to withstand wind pressure of 30 p.s.f., with deflection not to exceed 1/180 of span.
B. Frames shall be cold-formed or hot-rolled structural shapes as necessary to accommodate the door installation complete.



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SPECIFICATION FOR
COILING DOORS

1.0 General (continued)

- C. Furnish each coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components. Unless otherwise acceptable to owner, furnish all coiling doors by one manufacturer for entire project.

1.6 Submittals

A. Shop Drawings

1. Shop drawings for coiling doors shall include each door and frame, details of attachment, location of hardware, material, guides and accessories.
2. Indicate and fully dimension all details.
3. Manufacturer's product data and detailed installation and maintenance instructions for each door.

2.0 PRODUCTS

2.1 Manufacturers

- A. Subject to compliance with requirements, provide products of one of the following:
1. CECO/Windsor Door
 2. Cookson Co.
 3. Overhead Door Corp.
 4. Atlas Door Corp.

2.2 Materials

A. Hoods



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SPECIFICATION FOR
COILING DOORS

2.0 PRODUCTS (continued)

1. Fabricate steel hood for coil door of not less than 24 gage, hot-dip galvanized steel sheet with G-90 zinc coating, complying with ASTM A525. Phosphate treat before fabrication. Reinforce at the top and lower edges by rolled flanges.

B. Curtains

1. Shall be composed of painted interlocking galvanized flat-faced slats, roll-formed, not drawn, formed in easy curves without sharp bends, from open hearth steel.
2. Slat sections sufficiently large to give curtain strength adequate to safely resist specified wind pressure.
3. Provide insulated slats on doors in climate-controlled buildings, when shown on Door Schedule.
4. Ends of slats shall be equipped with slat lugs as wind locks to engage bars in guides and to lock the curtains with malleable iron end locks.
5. Bottom bars shall consist of two angles of equal size and weight, placed back to back, (galvanized or stainless steel to suit type of curtain slats). Provide replaceable gasket of flexible vinyl or neoprene between angles as a weather sill and cushion bumper.

C. Guides

1. Galvanized structural steel angles not less than 3/16 inch thick to form a slot of sufficient depth to retain curtains in guides against specified wind pressure and provided wind lock channels.
2. Guide assembly set plumb and bolted to jambs with 3/8 inch bolts not over 30 inches on centers. Provide removable stop on guides to prevent over travel of curtain and continuous bar for holding wind locks.



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SPECIFICATION FOR COILING DOORS			
2.0 <u>PRODUCTS (continued)</u>			
D. <u>Shafts in Hoods</u>			
1. Fabricated from standard pipes of adequate diameter to prevent deflection exceeding 0.03 inch per foot of door width under full load.			
2. Shafts to enclose oil tempered helical torsion springs of a design to insure proper counter-balancing action.			
3. Springs mounted on shaped anchors mounted on a single torsion rod.			
4. Spring tension adjustment by means of an adjusting wheel and pawl on the outside of the bracket plate.			
E. <u>Hardware</u>			
1. Manufacturer's standard hardware items, including lock, track, counter balance barrel, end locks and weather astragal.			
2. Cylinder for lock is specified in Section 08710.			
F. <u>Weather-Seal</u>			
1. Doors shall have weather-seal devices including an air baffle in the hood, wind locks on every slat, a rubber seal strip at jambs and compressible seal strip at the bottom of the door curtain.			
G. <u>Finish</u>			
1. Doors and hoods shall be galvanized per ASTM A525 and shall be chemically treated for paint adherence.			
2. Guides, end locks and fasteners shall be galvanized.			
3. Surfaces to be exposed shall be given one shop coat of manufacturer's standard rust-inhibitive primer.			



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SPECIFICATION FOR
COILING DOORS

2.0 PRODUCTS (continued)

H. Mechanical Operators

1. Chain-Gear Operator. Hand chain shall be galvanized. Gears shall be machined from high-grade gray cast iron. Gear reduction shall be calculated to reduce pull on hand chain to 35 pounds or less.
2. Crank-Gear Operator. Crank shall be removable and located approximately 2 feet 10 inches from floor. Gears shall be machined from high-grade gray cast iron. Gear reduction shall be calculated to reduce load on crank to 35 pounds or less.

I. Electrically Operated Doors

1. Electrically operated doors shall be provided with a compact operating unit designed and built by the door manufacturer and which will require a minimum of side clearance when installed. The unit is to be controlled by a three push button station marked "open", "close", "stop", and a screw adjustable limit switch which will break the circuit at a termination of travel.
2. The operator, consisting of a motor driven worm gear, shall be designed to operate the door at an approximate speed of one foot per second and to automatically release the motor from the driving unit prior to stalling to prevent overloading. The motor shall be a high starting torque type. The worm gearing, running in an oil bath, shall be furnished with a spring-set solenoid-operated brake, a magnetic reversing contactor in a NEMA Type 1 enclosure shall also be included. The electrical overload protective device shall be both heat and current sensing and installed integral with the unit.
3. An emergency hand chain operator which does not affect the timing of the limit switch shall be provided.



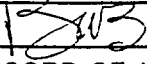

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SPECIFICATION FOR COILING DOORS			
2.0 <u>PRODUCTS (continued)</u>			
2.3 <u>Fabrication</u>			
A. All work shall be fabricated square, rigid, and in true alignment.			
B. Provide necessary reinforcing and appurtenant members and accessories.			
C. Surfaces shall be smooth and free from warps and buckles.			
3.0 <u>EXECUTION</u>			
A. Install doors complete with operator and hardware, under the supervision of the manufacturer or his authorized representative.			
B. Install doors completely weatherproof.			
C. Test and adjust doors for proper operation after installation.			

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00			NO. 08500		
			SPECIFICATION FOR ALUMINUM WINDOWS		
BY MHH	APPROVED 	ISSUE DATE 8/23/96			
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					SPECIFICATION FOR ALUMINUM WINDOWS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
MHH	<i>[Signature]</i>	08/23/96	0	08/23/96		

1.0 GENERAL

1.1 Description

A. This section describes the requirements for aluminum windows where shown on the drawings.

1.2 Related Sections

A. Section 07900 Sealant and Caulking

B. Section 08800 Glass and Glazing

1.3 Quality Assurance

A. Design Criteria

1. Installed windows shall safely resist a design wind load inward or outward of 30 pounds per square foot without permanent deformation.

2. Maximum allowable deflection shall not exceed 1/180 of the span under the design wind load.

1.4 Reference Standards (Latest Edition)

A. National Association of Architectural Metal Manufacturers (NAAMM) - Metal Finishes Manual.

B. FS QQ-A-200/9 Aluminum Alloy Bar, Rods, Shapes, Tube and Wire, Extruded 6063.

1.5 Submittals

A. Shop Drawings

B. Catalog Cuts and Brochures

C. Certification of Compliance with Design Criteria



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SPECIFICATION FOR
ALUMINUM WINDOWS

1.0 GENERAL (continued)

1.6 Product Delivery, Storage and Handling

- A. Protect windows from damage during transportation.
- B. Store under cover at the jobsite.

2.0 PRODUCTS

2.1 Approved Manufacturers

- A. Acorn Window System
- B. Architectural Product, Inc.
- C. Alenco

2.2 Materials

A. Window Type

Aluminum windows shall be provided with interior glazing. Windows type shall be as shown on the project drawings.

B. Frame Members

Frame members shall be extruded aluminum, alloy 6063-T5, not less than 1/8 inch in thickness and not less than 1-5/8 inches deep from front to back. Alloy shall conform to FS QQ-A-200/9.

C. Anchors and Reinforcing

Anchors and reinforcing shall be provided as required and shall be securely and properly fitted into place. Except as otherwise specified, fastenings, clips and other such parts shall be of non-magnetic stainless steel or aluminum. Surfaces of these parts shall not be exposed in the finished work except as approved.



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**SPECIFICATION FOR
ALUMINUM WINDOWS**

2.0 **PRODUCTS** (continued)

D. **Weatherstripping**

Windows shall be double weatherstripped using polypropylene pile securely interlocked into both inside and outside, weathering contact of ventilator sections.

E. **Hardware**

Projecting-in ventilators shall be balanced on heavy duty stainless steel screws and fitted with nylon slides with set screws for friction adjustment. Use stainless steel pins at all pivotal points. Equip ventilators with cast white bronze fastener. Awning windows to be provided with manufacturer's standard mechanical openers.

F. **Finish**

All exposed surfaces and appurtenances shall receive an anodized finish, AA-21C22A42, as specified in the NAAMM manual. Color shall be light bronze.

G. **Screens**

Furnish and install screens fabricated from 6063-T5 aluminum alloy extruded frames, or rolled shapes, with aluminum hardware and 18 x 14 mesh aluminum screen cloth.

2.3 **Fabrication**

A. Windows shall be fabricated to the dimensions and configuration shown.

B. Corners of window frames and the ends of closed members shall be carefully fitted to hairline joinery and securely Heli-arc welded for the full section profile. All projections shall be removed from within the glazing rabbets. Apply special acrylic or butyl seal at all intersections.

3.0 **EXECUTION**

3.1 **Installation**



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SPECIFICATION FOR ALUMINUM WINDOWS			
3.0 <u>EXECUTION (continued)</u>			
A. Windows shall be installed in accordance with the recommendations of the window manufacturer and as approved. Windows shall be braced as necessary to prevent distortion and shall be set straight, plumb, level and in true alignment.			
B. Aluminum which will be in contact with dissimilar materials shall be protected by painting the dissimilar material with a heavy coat of zinc chromate paint, a good quality caulking placed between aluminum and dissimilar material, or a non-absorbent tape or gasket.			
3.2 <u>Protection and Cleaning</u>			
After installation, protect windows from damage during subsequent construction activities. Upon completion, repair any marred and abraded surfaces.			

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			SPECIFICATION FOR FINISH HARDWARE		
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SPECIFICATION FOR
FINISH HARDWARE

1.0 GENERAL

1.1 Description

- A. This section describes the requirements for finish hardware as shown on the drawings.
- B. Work Includes:
1. Butts
 2. Threshold
 3. Silencers
 4. Lockset
 5. Door Closer
 6. Door Stop
 7. Push Plate, Pull Plate, Kick Plate
 8. Panic Hardware
 9. Weatherstripping
 10. Keys and Keying

1.2 Related Sections

- A. Section (08110) Steel Doors and Frames
- B. Section (08330) Coiling Doors

1.3 Quality Assurance

A. Requirements of Regulatory Agencies

Hardware for use on labeled openings shall conform to requirements of National Board of Fire Underwriters and Underwriters Laboratories Inc., and NFPA Standard No. 80.

1.4 Reference Standards (Latest Edition)

- A. American National Standards Institute (ANSI): "Designations for Builder's Hardware"



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SPECIFICATION FOR FINISH HARDWARE			
<p>1.0 <u>GENERAL</u> (continued)</p> <p>B. Door and Hardware Institute (DHI) "Recommended locations for builder's hardware for metal and custom wood doors and frames."</p> <p>C. Builders Hardware Manufacturers Association (BHMA) publications</p> <p>1.5 <u>Submittals</u></p> <p>A. <u>Shop Drawings and Product Literature</u></p> <p>Submit Finish Hardware Schedule for approval in same format as "Schedule of Finish Hardware Sets" noted on the drawings or specified herein, indicating manufacturer, catalog number and/or size, quantity, and finish. Submit catalog cut for each item. Contractor shall be responsible for determining the handing of doors and hardware and for correct count of all items necessary for complete and proper installation. Door location and swing shall be as shown on drawings.</p> <p>B. Samples as requested.</p> <p>1.6 <u>Product Deliver Storage and Handling</u></p> <p>A. <u>Packing and Marking</u></p> <p>Pack each item complete with all screws, bolts, washers and other accessories. Mark each container with corresponding set number from approved hardware schedule identifying its contents, room number and door mark of the finished work.</p> <p>B. <u>Delivery and Storage</u></p> <p>Receive and store all finish hardware. Properly tag, index and file all keys as directed. Deliver keys to owner's representative upon completion of work.</p> <p>2.0 <u>PRODUCTS</u></p> <p>2.1 <u>Materials</u></p> <p>A. <u>Cylinders and Keying</u></p>			



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SPECIFICATION FOR
FINISH HARDWARE

2.0 PRODUCTS - (continued)

1. Provide cylinders for following locksets furnished under other specification sections:

a. Coiling door(s)

2. Masterkey and grandmaster key all cylinders as directed by owner's representative. Provide masterkeys as directed for each masterkey set furnished. Coordinate with owner's project representative to interface with existing masterkey system.

B. Templates

1. Furnish promptly to door and door frame manufacturer(s), and other trades as required, each item or hardware requiring reinforcing and/or preparation.
2. Provide special tools, six of each type and size, required for installation or adjustment of hardware.

C. Key Cabinet

Provide Telkee, Inc., or approved equal surface mounted key cabinet with provision for 20 percent expansion, complete with all keys affixed to hooks and all file cards properly filled out and organized.

D. Fasteners

Furnish fasteners of proper type, size, quantity and matching finish for each article of hardware. Furnish machine screws and expansion shield for installation of hardware on concrete and masonry. Fasteners exposed to weather shall be stainless steel. Furnish tamper-proof one-way screws for hex bolts. Furnish self-tapping Phillips head stainless steel sheet metal screws for push/pull and kick plates.

E. Finishes

Finishes will be US32 D.



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**SPECIFICATION FOR
FINISH HARDWARE**

2.0 **PRODUCTS** - (continued)

F. **Panic Exit Devices**

Furnish exit devices on doors as scheduled on the drawings.

- G. Butts shall be full mortise, ball bearing, steel, template, flat button tip, non-rising pins (non-removable on exterior doors). Hinge weight shall suit door size and weight.

Butt size shall be as follows:

<u>Door Thickness</u>	<u>Door Width</u>	<u>Butt Size</u>
1-3/4"	Up to 36"	4-1/2" x 4-1/2"
1-3/4"	36" to 48"	5" x 4-1/2"

- H. The number of butts on each door leaf shall be as follows:

Doors 5'-0" high or less	-2 Butts
Doors over 5'-0" but not over 7'-6"	-3 Butts
Doors over 7'-6" high	-4 Butts

Butt locations shall be according to DHI, BHMA and ANSI guidelines.

I. **Locksets, Latchsets, and Exit Devices**

Verify that faces are suitable to fit door edge bevel or other shape, and provide strike with curved lip or size to clear jamb. Provide minimum throw of 1/2 inch on bored locks, 3/4 inch on mortise locks and 5/8 inch on pairs of doors.

J. **Closers**

All closers shall be suitable for 120° operation, unless otherwise scheduled. Furnish all closers to suit door size, weight and swing irrespective of closer size specified in hardware sets. Closers shall be equipped with regulating valves for control of latching speeds by means of removable key. All exterior door closers shall be mounted inside.



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SPECIFICATION FOR
FINISH HARDWARE

2.0 PRODUCTS - (continued)

K. Door Silencers

Provide three (3) silencers for each single door, and two (2) each leaf for each pair of doors. Silencers are not required for fire door installations, doors with sound proofing, or exterior doors.

L. Thresholds & Door Heads

All exterior door thresholds shall be set in full width bead of sealant. Where thresholds butt jambs, ship thresholds of sufficient width for field cutting and fitting. Provide rain drips on door frame at head of all exterior hollow metal doors which are not recessed.

M. Kick Plates

Kick plates shall be 8" high and full width of door leaf less 2", 18 gauge, stainless steel, except as otherwise called for on the schedule. Install kick plates on push side of doors.

N. Pull Plate

Install pull plate on the pull side of the doors, centered 42" above floor.

O. Push Plate

Install push plates on the push side of doors, centered 48" above floor.

P. Flush Bolts

Install flush bolts to inactive leaf of double door, at top and bottom. Provide dust-proof strike for foot bolt.

Q. Door Stop

Install doorstop at all doors exterior and interior.



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SPECIFICATION FOR FINISH HARDWARE			
2.0 <u>PRODUCTS</u> - (continued)			
R. <u>Weatherstripping and Seals</u>			
<p>General: Provide continuous weatherstripping on exterior doors and smoke, light or sound seals on interior doors, where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.</p> <p>Weatherstripping at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied.</p>			
2.2 <u>Approved Manufacturers</u>			
A. All hardware items specified herein by manufacturer name and catalog number are so specified for convenience to identify the quality, material, finish, operation and appearance of the various types of hardware.			
Substitutions may be made, subject to conformance with requirements and approval of owner.			
<u>Hardware Item</u>		<u>Acceptable Manufacturers</u>	
Butts, Hinges		Stanley, H. Soss, McKinney	
Latchset, Locksets and Lock Cylinders		Yale, Sargent, Schlage	
Closers		LCN, Norton, Yale	
Door Silencers		Ives, Bookline, Glynn Johnson (3 per Jamb)	
Thresholds Astragals, Weatherstripping		PEMKO, National Guard, Reese, Zero	
Kick Plate		Ives, Brookline, Quality	
Panic Exit Device		Yale, Monarch, Sargent	



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SPECIFICATION FOR FINISH HARDWARE

2.0 PRODUCTS (continued)

<u>Hardware Item</u>	<u>Acceptable Manufacturers</u>
Push/Pulls	Ives, Brookline, Quality
Coordination Device	Yale, Ives
Flush Bolt	Ives, Brookline, Quality

3.0 EXECUTION

3.1 Installation

- A. Coordinate hardware with doors and frames specified on the drawings.
- B. Where construction requires modification of hardware specified, substitute type of equal or better quality as approved by architect.
- C. Contractor shall provide all shims, spacers, etc., required for proper operation of finished installation.



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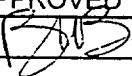
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				SPECIFICATION FOR GLASS AND GLAZING	
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SPECIFICATION FOR
GLASS AND GLAZING

1.0 GENERAL

1.1 Description

- A. This section describes the requirements for glass and glazing as shown on the drawings.

1.2 Related Sections

- A. Section (08110) Metal Doors and Frames

1.3 Quality Assurance

A. Requirements of Regulatory Agencies

1. Polished wire glass, where shown on the drawings, shall be in compliance with ANSI Z 97.1, latest edition, for use in hazardous locations as defined by applicable codes and state laws. Wired glass shall be listed by Underwriters Laboratories Inc. as fire retarding.
2. Tempered glass, where shown on the drawings, shall be in compliance with ANSI Standard Z 97.1 for safety glazing materials.
3. Exterior glass thickness shall be able to withstand, without damage, a wind pressure of 30 pounds per square foot.

1.4 Reference Standards (Latest Edition)

- A. Flat Glass Marketing Association: "Glazing Manual" and Glazing Sealing Systems Manual.
- B. ANSI Z 97.1: Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings
- C. ASTM C 920 Specification for Elastomeric Joint Sealant
- D. ASTM D 2240: Test for Rubber Property Durometer Hardness



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**SPECIFICATION FOR
GLASS AND GLAZING**

1.0 GENERAL (continued)

E. F.S.-DD-G-451C: Glass, Plate Sheet, Figured (Float Flat, for Glazing, Corrugated, Mirrors and Other Uses)

F. F.S.-DD-G-1403B &
F.S.-DD-G-1403C: Glass, Plate (Float), Sheet, Figured and Spandrel (Heat Strengthened and Fully Tempered)

G. F.S.-TT-S-230: Sealing Compound, Synthetic Rubber Base Single Component, Chemically Curing for Caulking, Sealing and Glazing in Building Construction

H. Consumer Product Safety Commission (CPSC) Standard 16 CFR-1201

I. Sealed, Insulated Glass Manufacturers Association (SIGMA)

1.5 Submittals

A. Samples

1. Wired Glass: Manufacturer's standard size

2. Sealant: Full color range

3. Vision Glass: Manufacturer's standard size

B. Manufacturer's Literature

1. Wired Glass

2. Tempered and Heat Treated Glass

3. Sealant

C. Certificate of Compliance

1. Wired Glass

2. Tempered and Heat Treated Glass



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SPECIFICATION FOR
GLASS AND GLAZING

1.0 GENERAL (continued)

3. Design Conditions

1.6 Product Delivery, Storage and Handling

A. Delivery of Materials

1. Manufacturer's labels showing strength, grade, thickness, type and quality will be required on each piece of glass.
2. Leave labels on glass until it has been set and inspected.
3. Deliver glazing materials to the site in unopened original containers bearing manufacturer's label specifying the quality, brand, trade name, curing time at 70°F and directions for use.
4. Inventory glass shipments immediately upon arrival at jobsite and notify carrier and/or supplier immediately in writing of any shortages, in-transit abuse, damage or wet packing.

B. Storage and Materials

Store glass and glazing materials as received in weathertight, dry place at site, not liable to incident damage of adjacent work. Protect glazing materials from freezing.

1.7 Job Conditions

A. Environmental Requirements

Do not apply glazing materials in temperature below 40°F during damp or rainy weather, or when temperature is above 100°F.

2.0 PRODUCTS

2.1 Materials

A. Tempered Glass

Provide tempered glass in thickness noted, conforming to Interim Federal Specification DD-G-1403, 16 CFR 1201, and ANSI Z 97.1, latest edition, and marked accordingly. Plate glass for tempering shall



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**SPECIFICATION FOR
GLASS AND GLAZING**

2.0 PRODUCTS (continued)

conform to Federal Specification DD-G-451C, latest edition, Type I, Class 1, Quality Q3. Tempered glass shall be minimum nominal 1/4 inch thickness, clean-cut at factory to suit opening.

B. Wire Glass

Provide 1/4 inch thick, clear wire glass "Polished Baroque" as manufactured by CE Glass, subsidiary of Combustion Engineering, Inc., ASG Industries, Libby-Owens-Ford, or any approved equal. Fire rated wire glass shall be listed by Underwriters Laboratories Inc. as approved fire-retarding materials and bear UL label.

C. Insulated Glass

Provide preassembled, permanently sealed, glass units, double thickness with air space to manufacturer's recommendation, conforming to SIGMA setting blocks, and spacer strips shall be furnished according to manufacturer's specifications.

D. Elastomeric Sealant

ASTM C920 in color as selected from manufacturer's standard range. Use Dow Corning 799 silicone sealant, or approved equal.

E. Glazing Tape

Pre-shimmed, self adhering, pre-formed elastomer containing 100% solids, polyisobutylene-butyl with integral continuous synthetic rubber shim, conforming to requirements of ASTM D2240. Use Tremco Manufacturing Company "Pre-Shimmed Tremco 440 Tape", or approved equal. In cases where sealant installations of heel and toe beads are difficult or not possible, use Tremco Manufacturing Company "Polyshim Tape", or approved equal.

F. Setting Blocks and Spacers

Solid neoprene, EPDM, or silicone blocks or extrusions with following sizes and ASTM D 2240 hardness ranges:



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**SPECIFICATION FOR
GLASS AND GLAZING**

2.0 PRODUCTS (continued)

Setting Blocks:
 Sizes Short "A" Hardness

Thickness Equal Glass 80-90 Points
edge; length minimum
4"

Spacers:
 Sizes Short "A" Hardness

2" to 3" long; Per manufacturer's
Sized to suit recommendations

G. Solvents and Cleaners

Solvents and cleaners shall be as recommended by glazing or sealing compound manufacturer.

3.0 EXECUTION

3.1 Preparation

Surfaces of rabbets, glass edges and stops or beads shall be clean, dry, free from dust, oil, rust and loose paint.

When sealing compound is used, surfaces in contact with compound shall be cleaned, by means of a solvent that leaves no residue. Solvent shall be applied with clean white cloth or lintless paper towels soaked in the solvent. Surfaces shall be wiped dry with clean white cloths or lintless paper towels before the solvent has air dried.

3.2 Fabrication

A. Glass Setting Dimensions

Following thicknesses and dimensions shall govern glazing unless otherwise specified herein:

Glass Type: Plate Float

Maximum Area: 100 Square Feet



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**SPECIFICATION FOR
GLASS AND GLAZING**

3.0 EXECUTION (continued)

Inch Thick:	1/4 Minimum
Cutting Tolerance:	$\pm 3/32$
Minimum Rabbet:	1/2 Inch
Minimum Edge:	11/64 Inch
Clearance Face:	1/8 Inch
Setting Block Height Range:	1/8 - 3/8 Inch

B. Glass Cutting

Field cutting or edge dressing of tempered glass or double-glazed insulating units shall not be permitted. Cut tinted glass to size in shop with clean-cut edges by approved manufacturer's instructions. Factory-cut tempered glass prior to reheating.

3.3 Installation

A. Install glass unless noted otherwise in accordance with instructions contained in following publications of the Flat Glass Marketing Association:

1. "Glazing Manual" (Latest Edition)
2. "Glazing Sealing Systems Manual" (Latest Edition)

B. Set all exterior glass by "Tape-Liquid Sealing Method" as follows:

1. Apply 1/8 inch minimum thickness preshimmed glazing tape over full face of back stop, using beveled tape to fit beveled stops and maintaining precise edge at sight line. Do not break tape except at corners and there seal together with longitudinal pressure. Set glass on neoprene setting blocks at quarter points allowing required clearance around full perimeter of glass. Allow no direct contact between glass and frame. Apply full heel bead of sealing compound around entire perimeter of glass. Set 1/8 inch minimum thickness spacer



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**SPECIFICATION FOR
GLASS AND GLAZING**

3.0 **EXECUTION** (continued)

shims on front face of glass as required to maintain uniform joint width, shove face stops into place and secure. Fill in and finish with sealing compound. Trim tape even with sight line and tool compound to tight joint.

C. Set all interior glass by "Channel Glazing Method" as follows:

1. Apply back-bed of elastic glazing compound over full face of back stop, and install spacer shims at least two (on each edge and not greater than 2 feet o.c.) to maintain uniform 1/8 inch thickness of bedding. Press glass into back bed of compound.

2. When glass size is more than 50 united inches (width plus height), install setting blocks at quarter points and use specified tape against fixed rabbet. Seal around entire perimeter of glass with elastic glazing compound. Apply secure face stops over 1/8 inch spacer shims and fill the space between face stops and glass with elastic glazing compound. Trim tape even with sight line and foot compound to tight joint.

D. Replace at no extra cost to the owner all glass not complying with specifications or broken during execution of work through defective materials or faulty installation.

E. Identify glazed openings with a colorful flag, festoon or tape suspended near, but not in contact with the glass. Attach tapes or banners to sash at head, jambs and sill with nonstaining adhesive or convenient mechanical means.

3.4 **Cleaning**

A. Clean glass of surplus glazing materials on both sides. Do not disturb glazing materials with scrapers. Do not use acid solutions or water containing caustic soaps.

B. Remove paint splashes, grease, smeared glazing compounds, stains, labels, and protective masking when construction work is completed.

DIVISION 9



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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO.: 35-K784-00

NO. 09250

SPECIFICATION FOR
GYPSUM WALL BOARD

BY	APPROVED	ISSUE DATE
MH	<i>[Signature]</i>	8/23/96

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SPECIFICATION FOR
GYPSUM WALL BOARD

1.0 GENERAL

1.1 Description

- A. This section describes the requirements for gypsum wall board as shown on the drawings.
- B. Items Included
 - 1. Furnishing and installing:
 - a. Framing and furring for gypsum board.
 - b. Gypsum board accessories and joint treatment materials.
 - c. Fire rated dry wall construction.
 - 2. Installation of steel door frames, metal louvers, access panels and reinforcing of wall hung cabinets and plumbing fixtures.

1.2 Related Sections

- A. Section (07900) Sealant and Caulking
- B. Section (08110) Metal Doors and Frames
- C. Section (09901) Architectural Painting

1.3 Quality Assurance

A. Qualifications of Applicator

Gypsum wall board shall be installed only by a reputable, qualified and experienced installer, with minimum three years experience in the field.

1.4. Reference Standards (Latest Edition)

- A. ASTM A525: General Requirements for Steel Sheet Zinc Coated by the Hot-Dip Process
- B. ASTM C36: Specifications for Gypsum Wall Board



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SPECIFICATION FOR GYPSUM WALL BOARD			
1.0 <u>GENERAL</u> (continued)			
C. ANSI A97.1: Application and Finishing of Wall Board			
D. ASTM C442: Gypsum Backing Board			
E. ASTM C475: Joint Treatment Material for Gypsum Wall Board Construction			
F. ASTM C630: Water Resistant Gypsum Backing Board			
G. ASTM C646: Steel Drill Screws for the Application of Gypsum Board			
H. ASTM E119: Fire Tests of Building Construction and Material			
I. SBC: Standard Building Code			
J. Federal Specifications HH-1-521F, Type 1			
1.5 <u>Submittals</u>			
A. <u>Product Data</u>			
1. Gypsum board and finishing materials			
2. Stud system and accessories			
1.6 <u>Product Delivery, Storage and Handling</u>			
A. All materials as specified shall be delivered to the job in original unopened containers and stored in a place protected from damage and exposure to the elements.			
1.7 <u>Job Conditions</u>			
A. <u>Environmental Requirements</u>			
In cold weather, the building shall be heated during and after application of gypsum wall board to maintain a uniform temperature in the range of 45 degrees F to 70 degrees F, and ventilation shall be provided to eliminate excessive moisture.			



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**SPECIFICATION FOR
GYPSUM WALL BOARD**

2.0 PRODUCTS

2.1 Materials

A. Gypsum wall board for finishes indicated, shall be standard board conforming to ASTM C36 with tapered edges as manufactured by U.S. Gypsum Co., Gold Bond, Georgia Pacific Corp., or an approved equal, and shall be of the grade as specified below. Gypsum board shall be 48 inches wide, and provided in lengths long enough to minimize end joints. Wall boards, framing, furring and accessories shall each be the product of a single manufacturer.

1.	Regular:	Grade R, 5/8 inch thick
2.	Fire-Retardant:	Grade X, 5/8 inch thick
3.	Water-Resistant: (ASTM C630)	Grade W/R, 5/8 inch thick
4.	Tile Backer Board:	Exterior Grade, 1/2 inch thick

B. Framing Components

1.	Studs shall be formed of hot-dip galvanized steel, 20 gauge or as noted on the drawings. At least two holes approximately 1-1/2 inches x 1-3/4 inches shall be punched within 18 inches of each end of each stud and holes punched approximately 24 inches on center for balance of stud length. Studs are to be 1-5/8", 2-1/2", 3-5/8", and 6" deep (as shown on the drawings) spaced at 16" O.C., unless noted otherwise.
2.	Floor and Ceiling Track: Roll-formed, 25 gauge, hot-dip galvanized steel channel track, width to match studs. Flanges shall be at least 1-1/4 inches high.

C. Fasteners

1.	Gypsum Board to Metal Studs: Self-drilling Type S Phillips head dry wall screws, 1 inch long for single layer; Type S-12 for 20 and 16 gauge framing, conforming to ASTM C646.
2.	Studs and Stud Tracks to Adjacent Construction: Use Ramset or Phillips power-actuated fasteners. Concrete stub nails may be used for securing floor tracks.



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**SPECIFICATION FOR
GYPSUM WALL BOARD**

2.0 PRODUCTS (continued)

D. Accessories

1. Corner bead shall be USG 104 DUR-A-BEAD, galvanized 1-1/8 inches x 1-1/8 inches perforated for nailing and joint treatment.
2. Casing beads shall be USG 200-A or 200-B, as required, for finishing with joint compound.
3. Control joints shall be strip vinyl extrusion expansion joints.

E. Tapes and Compounds

1. Tape shall be standard joint reinforcing USG Perf-A-Tape for all gypsum wall board application, as recommended by the gypsum wall board manufacturer.
2. Joint compound shall be ready-mix type, as recommended by the gypsum board manufacturer and shall conform to ASTM C475.

3.0 EXECUTION

3.1 Installation

A. Gypsum board shall be applied with the reverse side against the framing members and with the separate boards in moderate contact. In no case shall the boards be forced into place. At interior and exterior corners, the cut edges of gypsum board shall be concealed by overlapping them with the abutting boards. Vertical joints shall not occur on the same stud on both sides of a wall or partition.

B. Gypsum board shall be secured to studs and furring using drive screws in accordance with ANSI A97.1. The wall board adjacent to the point of fastening shall be held tightly against the framing while driving screws. Dependence on drive screws to draw gypsum board against the framing will not be acceptable. The drive screws shall be driven not less than 3/8 inches from the edges and ends of gypsum board. Drive screws shall be power driven in accordance with the recommendations of the manufacturer, and as approved. Screws shall be driven until the head rests in the shallow dimple-like depression, care being taken not to crush the core of the board or the surface of the paper.



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**SPECIFICATION FOR
GYPSUM WALL BOARD**

3.0 EXECUTION (continued)

Drive screws at abutting edges and ends of the boards shall be in alignment (not staggered). Maximum possible size of boards shall be used to minimize joints. At the fire rated partitions, boards shall be vertical with joints on opposite sides of partitions, staggered in accordance with the tested design.

C. Cementing and taping of gypsum board joints shall be in strict accordance with the manufacturer's printed recommendations. Depressions shall be filled with joint cement. Filled joints and depressions shall be lightly sanded to leave flush, smooth surfaces. Paper surface of wall board shall not be scuffed when sandpapering.

D. Wall Installation

Runners shall be aligned accurately at floor and ceiling and securely anchored with suitable fasteners spaced not more than 24 inches on centers. Provide a double bead of caulking under floor and ceiling runners.

E. Studs shall be positioned vertically in the runners, spaced no greater than 16 inches on centers. Anchor all studs located adjacent to door and window frames, partitions, intersections and corners to runner flanges by positive screw engagement through each stud flange and runner flange. Studs shall be located not more than 2 inches from all door frame jambs, abutting partitions, partition corners and other construction.

F. Studs shall be securely anchored to the jamb and head anchor clips on each door or borrow light frame by bolt or screw attachment. Over metal doors, provide a header section fabricated of a cut-to-length section of runner with flanges slit and webs bent at each end; place horizontally and securely screw-attach to adjacent vertical studs. A cut-to-length stud shall be positioned at the location of vertical joints over the door frame header extending to the ceiling runner. Door and window openings shall be framed with two 20-gage studs fastened together to form a box column at each jamb.

G. Gypsum wall board shall be applied vertically with all abutting ends and edges over stud flanges. Screw fasteners shall be spaced a maximum of 12 inches on centers in the field of the board and 12 inches on centers along the vertical abutting edges.



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SPECIFICATION FOR GYPSUM WALL BOARD			
3.0 <u>EXECUTION</u> (continued)			
H. For fire rated walls, the boards shall be applied vertically with joints on opposite sides of the partition, staggered in accordance with the tested design.			
I. On long continuous runs, provide for expansion approximately every 40 feet. Joints shall be formed by using a casing bead, floor to ceiling, on each exposed edge.			
J. <u>Supplementary Framing</u>			
Install supplementary framing, blocking and bracing at terminations in the work, and for support of fixtures, services, heavy trim, grab bars, toilet accessories or partitions and similar construction.			

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SPECIFICATION FOR CERAMIC TILE					
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1.0 GENERAL

1.1 Description

A. This section describes the requirements for ceramic tile as shown on the drawings.

1.2 Related Sections

A. Section (03300) Cast-In-Place Concrete

B. Section (10800) Toilet and Bath Accessories

C. Section (07900) Sealant and Caulking

1.3 Quality Assurance

A. Reference Standards (Latest Edition)

1. TCA 117.1: Specifications for Ceramic Tile
2. Tile Council of America (TCA) Handbook for Ceramic Tile Installation
3. ANSI A 118.1: Specification for Dry-Set Portland Cement Mortar
4. ANSI A 108.1: Specification for Installation of Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile, and Paver Tile with Portland Cement Mortar
5. ANSI A 108.2: Specification for Ceramic Mosaic Tile Installed with Portland Cement Mortar
6. ANSI A 108.5: Specification for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar
7. ASTM C 150: Specification for Portland Cement
8. ASTM C 207: Specification for Hydrated Lime for Masonry Purposes



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**SPECIFICATION FOR
CERAMIC TILE**

1.0 GENERAL (continued)

9. ASTM C 144: Specification for Aggregate for Masonry Mortar

10. FS TT-S-00230C: (2) Sealing Compound, Elastomeric Type, Single Component

11. FS TT-S-227B: (1) Sealing Compound, Rubber Base, Two Component

1.4 Approved Manufacturers

A. American Olean Tile Division

B. United States Ceramic Tile

C. Dal-Tile

D. Florida Tile

1.5 Submittals

A. Submit the Following

1. Samples and Product Data

a. Floor Tile

b. Wall Tile

c. Trim Shapes

d. Edge Strips

e. Grout Colors

2. Certificates

a. Tile Council of America

b. For mortar and grout materials suitable for intended use and meeting ANSI and ASTM requirements.

3. Extra Stock

a. Provide not less than 5% each type and color tile used.



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**SPECIFICATION FOR
CERAMIC TILE**

1.0 **GENERAL** (continued)

b. Provide sufficient mortar and grout materials for the proper installation of extra stock.

1.6 **Product Delivery, Storage Handling**

A. Deliver materials in manufacturer's original sealed containers with labels legible and intact.

B. Handle and store materials to prevent damage and inclusion of water.

1.7 **Job Conditions**

A. **Environmental Requirements**

1. Set and grout tile when ambient temperature is at least 50° F (10°C) and rising and is maintained without interruption for at least seven days after completion of work.

2. Vent temporary heaters to outside to avoid carbon dioxide damage to new tile work.

B. **Protection**

1. Protect adjoining work surfaces before tile work begins.

2. Cover finished floor surfaces with heavy building paper before foot traffic is permitted.

3. Place board walkways on floors that are to be used as passageways.

2.0 **PRODUCTS**

2.1 **Materials**

A. Provide tile sizes and finishes specified herein of Standard Grade conforming to TCA 117.1. Include matching trim units as necessary for a complete and neatly finished installation.



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SPECIFICATION FOR CERAMIC TILE			
2.0 <u>PRODUCTS</u> (continued)			
1. Glazed wall tile shall be 4-1/4 inch by 4-1/4 inch by 5/16 inch thick, standard grade, nonvitreous, plain faced with square edges. External corners shall be bull nose, internal corners square, and special shapes as required.			
2. Unglazed ceramic floor tile shall be 2 inch by 2 inch standard grade, vitreous, natural clay tile, plain faced with square edges. Tile shall be laid to patterns selected.			
3. Matching trim units, including trimmers and specified shapes, shall be provided where indicated or as necessary for a complete installation.			
B. Marble thresholds, 1/2" thick tapering to 1/4" thick with sand-rubbed finish, shall be used where finish floor elevations are not the same. Provide approved light gray, veined Missouri or Vermont marble thresholds with corners and unprotected edges slightly rounded at door opening to toilet rooms and where tiled floor meets floor of dissimilar material.			
C. Portland cement shall be white, conforming to ASTM C 150, Type I.			
D. Lime shall be hydrated Type "S" conforming to ASTM C 207.			
E. Sand shall be sharp, washed clean, durable, uncoated particles free from silt, loam, clay, soluble or organic impurities and shall conform to ASTM C 144.			
F. Water shall be potable and shall be free of any impurities that would be detrimental to construction.			
G. <u>Mortar</u>			
Tile cement mortar for floors and walls (thin-set) shall be dry set Portland Cement Mortar conforming to ANSI A 118.1.			
H. <u>Grout</u>			
Provide waterproof non-staining white Portland cement conforming to ASTM C 150 for grout.			



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**SPECIFICATION FOR
CERAMIC TILE**

2.0 PRODUCTS (continued)

I. Expansion and Control Joints

1. Back-up material for joints to receive sealant shall be flexible and compressible non-staining material, compatible with sealant.

2. Sealant shall be non-sag type for vertical surfaces and self-leveling type for horizontal surfaces, and shall be single-component, elastomeric type complying with Federal Specification TT-S-00230, or two component rubber-base type complying with Federal Specification TT-S-227b.

J. Water Proofing Membrane

At shower areas, water proofing membrane shall be copper fabric membrane as manufactured by York Manufacturing Inc., or "Laticrete" No. 9236 or MER-KRETE 300, as manufactured by Laticrete International.

3.0 EXECUTION

3.1 Inspection

A. Surfaces shall be clean, dry, true, firm and in proper condition for bonding of tile. All open spaces and cutouts shall be packed with tile cement, or as otherwise approved.

B. Leveling coats for floors to receive ceramic tile shall be provided to the proper thickness on all floor surfaces as required and as recommended by the manufacturer.

C. Lay out tile on floors and walls so that no tile less than half size occurs.

3.2 Installation

A. Ceramic tile and appurtenances shall be set, grouted and cleaned in accordance with the recommendations of the Tile Council of America "Handbook for Ceramic Tile Installation" and ANSI Standard Specification A 108.2 and A 108.5 and as follows.



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**SPECIFICATION FOR
CERAMIC TILE**

3.0 EXECUTION (continued)

B. Dry set thin bed installation for floors and walls: Level surfaces for dry set thin bed installations to a tolerance of plus or minus 1/8 inch per eight feet distance. Attest to conformance with this basic preliminary requirement. Commencement of work shall constitute acceptance of areas to be covered as satisfactory for the installation of tile. Install dry set thin bed installations in strict accordance with standard practices set forth in ANSI A 108.5 and A 118.1. Give tile sufficient beats to assure that more than 40 percent of each tile is covered with mortar. To obtain full contact with rib-backed tile, trowel a layer of mortar on the back of each tile prior to placing in the mortar bed. If face-mounted sheets are used, wet and remove paper before initial set. Avoid use of excess water.

1. Bring each tile to true level and plane by uniformly applied pressure. Remove and reset tiles that are out of true plane or misplaced.
2. Make uniform width joints between tiles. Fractional changes in dimensions without varying the uniformity of joint width will be permitted.
3. Cut tile with a suitable cutting tool and smooth rough edges. Replace cut tile misfits with properly cut tile.
4. Lay tile to the straight edges. Accurately set straight edges to the line established and reset at suitable intervals to keep joints parallel over the entire area.
5. Bed marble thresholds properly, neatly, and provide necessary rabbeting for jambs and underscore as required to fit over materials varying in thickness.
6. Provide joint filler and sealant at perimeter and around all pipes or such other part which go through floors so as to obtain watertight construction.
7. Ensure that joints in tile work are plumb, level and in alignment. Space joint widths to accommodate the tile in the given spaces with a minimum of cutting, except maintain standard mounting widths between units and abutting sheets of paper mounted mosaic tile.



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SPECIFICATION FOR
CERAMIC TILE

3.0 EXECUTION (continued)

8. Determine joint width for mounted ceramic tile by the mounted tile spacing.

9. Provide joint width for unmounted ceramic tile of 1/16 inch average with a maximum of 1/8 inch.

10. Provide joint width for trim units conforming to that of adjoining tile units. Control joints shall be provided in floors as specified and/or shown. Cut through setting beds at perimeter joints and at projections through the floor. Install temporary fiber board filler for later joint completion under section, Caulking. Provide control joints where floor tiles meet restraining surfaces such as perimeter walls, curbs, columns, pipes, etc., and directly over control or expansion joints in sub-surfaces. Control joints shall not exceed twenty-four feet on centers each way in floors and shall be located as approved. Form control joints in neat, straight lines. Cut tiles cleanly and to accurate radius at exposed junctions. Tile control joints shall be full width of control joints in sub-surface and same width as grouted joints in tile work.

11. Install waterproof membrane in accordance with manufacturer's recommendations over concrete slab subfloor in all showers and other areas as indicated on the drawings.

C. Grouting and Pointing

Grout joints with grouts specified. Force grout into and completely fill joint spaces using methods referenced above. Avoid scratching finishes. Remove all surplus grout before it hardens.

D. Curing

1. Walls grouted with dry set thin bed grout specified do not require a cure.



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SPECIFICATION FOR
CERAMIC TILE

3.0 EXECUTION (continued)

2. Cure and protect floors by covering them with a "Sisalkraft" paper or polyethylene sheet cover layer for a minimum of three days. If possible, continue curing for the full ten days protection period against trucking. Check daily and maintain dampness. Allow no foot traffic on floors for 48 hours, erect barricades and post signs.

E. Cleaning

1. Use only fiber brushes. Metal scrapers, wire brushes, steel wool, or muriatic acid are not permitted. Perform floor cleaning 24 hours after the curing paper or polyethylene sheeting has been removed. Use the following materials or approved equals:
2. Ceramic floor and wall tile: Process Solvent Co., "Sure Klean T-041", or available equivalents by Euclid Chemical Co. or Standard Dry Wall Products, Inc.

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JEG JOB NO.: 35-K784-00

NO. 09511

SPECIFICATION FOR INTERIOR
ACOUSTICAL CEILING

BY

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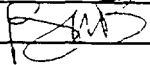
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					SPECIFICATION FOR INTERIOR ACOUSTICAL CEILING	
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1.0 GENERAL

1.1 Description

A. This section describes the requirements for acoustical ceilings as shown on the drawings.

1.2 Quality Assurance

A. Design Criteria

1. All suspension system parts shall be galvanized and shall be of suitable design, ample strength and rigidity to meet requirements of ASTM C 635.

2. All acoustical ceiling material shall have a maximum fire hazard classification of 25 for flame spread and fuel contributed, and 50 for smoke developed, in accordance with ULI 40-U 8.1.

1.3 Reference Standards (Latest Edition)

A. FS-SS-S-118a: Sound Controlling Blocks and Boards (Acoustical Tile and Panels, Prefabricated)

B. ASTM A 525: General Requirement for Steel Sheet Zinc Coated by the Hot-Dip Process

C. ASTM C 423: Test for Sound Absorption and Sound. Absorption Coefficient by the Reverberation Room Method

D. ASTM C 523: Test for Light Reflectance of Acoustical Materials by the Integrated Sphere Reflectometer

E. ASTM C 635: Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.

F. ASTM C 636: Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels

G. ASTM E 84: Test for Surface Burning Characteristics of Building Materials



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SPECIFICATION FOR INTERIOR
ACOUSTICAL CEILING

1.0 GENERAL (continued)

H. ASTM D 1779: Adhesive for Acoustical Material

I. ULI 40-U 8.1: Building Material List: Acoustical Material

1.4 Submittals

A. Brochure or Product Data

1. Acoustical ceiling units

2. Suspension system

B. Maintenance Materials

1. Provide one extra full and unopened carton (not less than 6 units) of each type of acoustical ceiling unit for use in future maintenance or replacement.

1.5 Product Delivery, Storage and Handling

A. Deliver materials to the site in original packages or containers bearing the manufacturer's label and identification.

B. Store and handle materials so as to prevent damage or introduction of foreign matter or moisture.

1.6 Job Conditions

A. Environmental Requirements

1. Conform strictly to the manufacturer's installation recommendations before, during and after installation.

2. Start no work until all glazing has been completed and all exterior openings closed in.

3. Maintain uniform temperature not less than 60 degrees F nor more than 100 degrees F and maximum relative humidity of 80 percent before, during and after installation.



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SPECIFICATION FOR INTERIOR
ACOUSTICAL CEILING

1.0 GENERAL (continued)

3. Maintain uniform temperature not less than 60 degrees F nor more than 100 degrees F and maximum relative humidity of 80 percent before, during and after installation.

2.0 PRODUCTS

2.1 Acceptable Manufacturers

A. Standard Panels, Suspension Systems

1. Armstrong
2. Chicago Metallic Corporation
3. Donn Productions
4. Celotex Corporation

B. Moisture-Resistant Panels

1. Gold Bond
2. Armstrong
3. Celotex

2.2 Materials

A. Acoustical ceiling units shall meet the following requirements:

1. Flame Resistance

a. Class 25 in accordance with Federal Specification SS-S-118a, ULI 40-U 8.1.

2. Flame Spread Index

a. "I" or lower as determined by ASTM E 84.

3. Light Reflection Range

a. .75 or more as determined by ASTM C 523.

4. Noise Reduction Coefficient

a. .60 - .70 in accordance with ASTM C 423.



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SPECIFICATION FOR INTERIOR ACOUSTICAL CEILING			
2.0 <u>PRODUCTS</u> (continued)			
5. <u>Pattern and Size - Standard Panels</u>			
a. Unless otherwise specified, lay-in panels shall be 24 inches by 48 inches by 5/8 inch, white, random fissured pattern.			
6. <u>Moisture-Resistant Panels</u>			
a. Provide Gold Bond "Gridstone"; Armstrong "Ceramaguard", or approved equal. 24 by 48 inches, with white finish.			
B. Exposed grid suspension system shall include steel main runners of "Intermediate Duty" load-carrying capability per ASTM C 635. Wide-face capped double-web construction, of galvanized steel, G50 per ASTM 525. Finish shall be manufacturer's standard white enamel.			
1. Provide all associated appurtenances including hold-down clips and perimeter moldings and fasteners for use at abutting walls and other vertical surfaces.			
2. Hanger wire shall be a minimum of No. 12 gauge, galvanized dead soft wire.			
3. Tie wire shall be minimum No. 18 gauge, galvanized dead soft wire.			
C. Unless otherwise specified, tiles shall be 12 inches x 12 inches x 5/8 inch thick with a beveled edge. Example is Armstrong Cork-Minatone, Fissured Tile. Adhesive shall conform to ASTM D 1779. Caulking shall be non-staining type.			
3.0 <u>EXECUTION</u>			
3.1 <u>Preparation</u>			
A. Install suspension system and acoustical ceiling units in strict accordance with requirements of ASTM C 626 and as follows:			



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SPECIFICATION FOR INTERIOR ACOUSTICAL CEILING			
3.0 <u>EXECUTION</u> (continued)			
1. The areas to receive ceilings should be carefully laid out to provide symmetrical borders which are not less than half the size of the tile or panel specified, unless shown on architect's reflected ceiling plan.			
2. <u>Structural Anchorage</u>			
a. Fasten hangers four feet on centers along main runners to structural elements with standard tie nooses or fastened to inserts, eyescrews, or other secure devices appropriate to the structure. Do not attach hangers to steel deck, duct work, pipes, conduit, etc. Attach only to structural members.			
b. Suspend light fixtures from their four corners, independently from the grid.			
3. Install suspension system in true and level plane with members parallel to partitions. Attach cross runners through pre-cut slots in main runners, locking webs together by means of die-formed end tabs to provide positive interlock with main runner. Intersections of all main runner, cross runner and perimeter molding flanges shall have flush flange joints. Install, in accordance with manufacturer's instructions, main runner splices where required, and perimeter moldings at all junctions with walls and other vertical surfaces. Perimeter moldings shall be mitered or corner capped where all moldings intersect.			
4. Provide all necessary framing to support ceiling at openings for light fixtures, ventilating ducts, etc. Provide spring-steel hold-down clips at a minimum of four points per ceiling unit.			
5. Install acoustical ceiling units and modify system or arrangement of units as directed by the Owner's Project representatives, to facilitate access to valves, clean-outs, electrical boxes, dampers and other pieces of mechanical or electrical equipment. Identify units designed for such access with cadmium-plated screws or as directed.			



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SPECIFICATION FOR INTERIOR ACOUSTICAL CEILING			
3.0 <u>EXECUTION</u> (continued)			
6. <u>Lateral Bracings</u>			
Furnish and install lateral bracing of minimum 12 gage wire splayed 45 degrees as follows.			
At mid point of all unsupported partitions exceeding twelve linear feet. At twelve feet on center each way in all large ceiling areas not restrained by partitions. Secure all lateral bracing to structural members, secure at right angles to the direction of the partition and four ways in large ceiling areas.			
7. <u>Cemented-On Acoustical Units</u>			
a. Daub acoustical tile units on backside with four equal daubs of adhesive applied near the corner of tiles.			
b. Press units into place, aligning joints and abutting units tight and uniform without differences in joint widths.			
3.2 <u>Cleaning</u>			
Clean exposed surfaces free of all dirt, finger marks and foreign matter caused by handling or installation. Remove and replace units which are damaged or improperly installed.			

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Jacobs Engineering Group, Inc.
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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO.: 35-K784-00


NO. 09650

SPECIFICATION FOR
RESILIENT FLOORING

BY	APPROVED	ISSUE DATE
MH		8/23/96

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1.0 GENERAL

1.1 Description

A. This section describes the requirements for resilient tile as shown on the drawings.

1.2 Related Sections

A. Section (09310) Ceramic Tile

1.3 Submittals

A. Product Data

1. Adhesive

2. Manufacturer's standard colors and patterns

B. Samples

1. Vinyl composition tile

2. Vinyl base

3. Edge strip

C. Extra Stock: Furnish not less than one (1) box of tiles for each 50 boxes or fraction thereof, for each type, color, size, and pattern installed.

1.4 Product Delivery, Storage and Handling

A. Deliver resilient flooring materials to job site in original unbroken containers with the manufacturer's brand name marked clearly thereon.

B. Store materials at a temperature of not less than 70 degrees F, for a minimum of 12 hours before installation.



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**SPECIFICATION FOR
RESILIENT FLOORING**

1.0 **GENERAL** (continued)

1.5 **Job Conditions**

A. **Environmental Requirements**

1. Maintain temperature of 70 degrees F, for at least 48 hours before, during, and after installation of resilient flooring.

2. Provide ventilation to remove moisture and volatile fumes.

1.6 **Reference Standards** (Latest Edition)

A. FS SS-T-312: Tile, floor, asphalt, rubber, vinyl, vinyl composite Type I and Type IV.

B. FS SS-W-40A: Wall base: vinyl plastic Type I and II.

2.0 **PRODUCTS**

2.1 **Acceptable Manufacturers**

A. Vinyl Composition Tile and Vinyl Base

1. Armstrong

2. Azrock

3. Flexco

4. Vinyl Plastics Inc.

5. Kentile

6. GAF Corporation

2.2 **Materials**

A. Vinyl composition tile shall be (asbestos-free) 12 inch by 12 inch and shall be 1/8 inch in thickness. Border tile shall be not less than 4-1/2 inches wide. Tile shall be accurately cut with square true edges and uniform thickness. Tile shall conform to FS-SS-T-312.

B. Tile pattern shall be as selected by architect.



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SPECIFICATION FOR RESILIENT FLOORING			
2.0 <u>PRODUCTS</u> (continued)			
C. Color shall be selected from the manufacturer's standard line of colors. Colors appearing on surface of tile shall extend in same shades and in same proportions throughout entire thickness of tile.			
D. Wearing surface of tile shall present a smooth polished appearance free from defects affecting appearances or durability and shall be factor waxed.			
E. Primers, adhesives, latex underlayment and fillers ("floor patch") shall be as recommended by the resilient tile manufacturer.			
F. Vinyl wall base shall be 4 inches high, 1/8 inch thick and shall be of the top set type with ribbed back and rounded top and approximately a 19/32 inch wide cove at the toe. Inside and outside corners shall be of the preformed type. Vinyl wall base shall be as manufactured by Azrock Floor Products, Kentile Floors or equal conforming to FS SS-W-40A, Type II, vinyl with cove.			
G. Metal edge strips, as required, shall be extruded aluminum, bevel ended sections as manufactured by Julius Blum & Company of Carlstadt, N.J., J.G. Braun Company of New York, N.Y., or Zero Weatherstripping, or equal.			
3.0 <u>EXECUTION</u>			
3.1 <u>Condition of Surfaces</u>			
A. Concrete surfaces shall be clean, dry and free from loose particles that will impair bond. Inspect surfaces and correct all irregularities and defects that will impair bond. Installation of flooring will be construed as acceptance of the surface.			
3.2 <u>Preparation</u>			
A. Fill small cracks or depressions with latex underlayment not to exceed 1/2 inch thick and apply as recommended by the manufacturer.			
B. Concrete masonry unit surfaces to receive vinyl base shall be given two coats of latex filler to insure adhesion to the base. Allow filler to dry thoroughly before installation of the base.			



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SPECIFICATION FOR RESILIENT FLOORING			
3.0 <u>EXECUTION</u> (continued)			
3.3 <u>Installation</u>			
A. Lay resilient flooring after all other trades, including painting, have completed their work.			
B. Install floor tiles in strict accordance with the recommendations of the manufacturer.			
C. Joints shall be tight and in true alignment and shall be laid symmetrically about center-lines of areas. Lay tiles in "checkerboard" fashion with grain reversed in adjacent tiles.			
D. Secure metal edge strips under the resilient flooring at doors as indicated or required and provide a beveled transition between resilient flooring and concrete floor. Apply strips at inside face of outswinging doors.			
E. Neatly fit vinyl base to floor and walls and accurately fit to recesses and projections. Use premolded corners.			
F. Finished work shall not show more than hairline cracks; it shall be free of waves, projecting edges and buckles and shall be carefully fitted with other materials and shall be protected from traffic until the flooring is firmly set.			
3.4 <u>Cleaning</u>			
A. Thoroughly clean and wax surfaces in accordance with the recommendations of the flooring manufacturer.			
B. Buff surfaces to an even luster and completely protect with heavy duty paper before traffic is permitted.			
C. Provide boardwalks in areas subject to floor damage from subsequent building operations.			

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OTIS ANGB, MA
JEG JOB NO. 35-K-784-00

NO. 09870

BY BW	APPROVED 	ISSUE DATE 8/19/96
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SPECIFICATION FOR
INTERIOR LINING SYSTEM FOR STEEL
STORAGE TANKS

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1.0 GENERAL

1.1 DESCRIPTION

1.1.1 This specification covers surface preparation, application and inspection of epoxy non-reinforced thin film coatings.

1.1.2 ITEMS INCLUDED

A. Preparing surfaces and applying coating to all scheduled surfaces.

B. Touching up and repairing damaged and defectively coated surfaces.

C. Testing and inspecting.

D. Documentation.

1.2 RELATED SECTIONS

Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01300	Submittals

1.3 REFERENCE STANDARDS (Latest Edition)

NACE RP0178-89	Design, Fabrication and Surface Finish of Metal Tanks and Vessels to be Lined for Chemical Immersion Service
NACE No. 1 (SSPC-SP5)	White Metal Blast Cleaning
SSPC-PA2	Measurement of Dry Paint thickness with Magnetic Gauges
ANSI Z53.1	Safety Color Code For Marking Physical Hazards
API 2015	Cleaning Petroleum Storage Tanks for Application of Protective Lining
ASTM D 4285	Indicating Oil or Water in Compressed Air
ASTM D 4417	Field Measurement of Surface Profile of Blast Cleaned Steel



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS			
1.0 GENERAL (continued)			
ASTM E 337	Test for Relative Humidity by Wet-And-Dry Bulb Psychrometer		
Fed. Std. 595a	Colors		
OSHA 29CFR1910.144	Safety Color Code		
OSHA 29CFR1910.1200	Hazardous Communication Standard		
OSHA 29CFR1926.59	Labeling of Hazardous Materials		
SSPC AB1	Abrasive Specification No. 1 Mineral and Slag Abrasive		
SSPC SP1	Solvent Clean		
SSPC SP2	Hand Tool Cleaning		
SSPC SP3	Power Tool Cleaning		
SSPC SP5	White Metal Blast Cleaning		
SSPC SP11	Power Tool Clean to Bare Metal		
SSPC VIS1	Visual Standards for Abrasive Blast Cleaning Steel		
SSPC PA2	Measurement of Dry Paint Thickness with Magnetic Gauges		
1.4 SUBMITTALS			
1.4.1 All documentation shall be in accordance with Section 01300, Submittals.			
1.4.2 A listing of coating systems and material to be used on each item, shall be in accordance with this specification. Components, or pieces of equipment shall be submitted for review and approval. This shall include the Vendor/Contractor written proposed system of work which identifies the specific products by manufacturer and catalog number.			
1.4.3 For paint systems selected from this specification, the Vendor/Contractor shall provide written procedures for storage, handling, surface preparation, environmental control, application, touch-up and repair, curing, and inspection. This shall be submitted for review and approval to proceed prior to use. Conflicts, if any, between the coating manufacturer's recommendations and this specification shall be noted in writing to the Owner/Engineer for resolution.			



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1.0 GENERAL (continued)			
1.4.4 The Vendor/Contractor proposed cleaning and coating verification forms for daily inspection records shall be submitted for review. Following review and acceptance of this form, a completed form shall be submitted for each item coated.			
1.4.5 Vendor/Contractor shall submit the manufacturer's volatile organic compound (V.O.C.) data sheets and Manufacturers Safety Data Sheet (MSDS) for review.			
1.5 DEFINITIONS			
A. "OWNER" - the OWNER or the OWNER's representative.			
B. "VENDOR/CONTRACTOR" - the equipment fabricator, supplier, or subcontractor.			
C. "ENGINEER" - Design Engineer			
1.6 SHIPPING, HANDLING AND STORAGE			
1.6.1 Coating materials shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number, and date of manufacture. Containers which are damaged shall not be used.			
1.6.2 The material shall be handled and stored in accordance with the manufacturer's latest published instructions and shall be protected from damage, moisture, direct sunlight, and temperatures below 40°F or above 90°F.			
1.6.3 The coating materials shall be used within the manufacturer's recommended shelf life.			
1.6.4 Containers of coatings or components shall not be opened unless for immediate use.			
1.6.5 All usable paint cans and solvent containers must be kept in a designated place and must be marked clearly for good housekeeping practice.			
2.0 PRODUCTS			
2.1 MATERIAL MANUFACTURERS			
2.1.1 Unless otherwise specified, all coating material shall be as specified by the Owner in Appendix "A". Materials from other manufacturers shall not be used without prior approval of the Owner/Engineer.			



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS			
2.0 PRODUCTS (continued)			
2.1.2 Appendix A contains a list of acceptable products that have been approved for use. Only products listed in this Appendix shall be used.			
2.1.3 Contractor shall only use coatings complying with federal, state and local air pollution regulations. Volatile organic compounds (V.O.C.) must be below 420 grams/liter.			
2.2 ENVIRONMENTAL REQUIREMENTS			
2.2.1 All coatings specified shall be free of lead (less than .01%) and shall contain no chromate pigments.			
2.2.2 In all cases, low V.O.C. coatings shall be specified less than 2.8 lbs. per gal.			
2.3 MACHINED-SURFACE COATINGS			
2.3.1 Machined surfaces shall be protected with a temporary preservative which meets the requirements of MIL-C-16173, Grade 1.			
2.4 ABRASIVE MATERIALS			
2.4.1 Abrasives for blast cleaning shall be clean and dry, furnished either in bulk or packaged, and shall be free of oil or contaminants. The particle size shall be capable of producing the specified surface profile. Mineral and slag abrasives shall meet the requirements of SSPC AB-1.			
2.5 THINNERS, SOLVENTS, AND CLEANERS			
2.5.1 Thinners, solvents, and cleaners shall be as manufactured or recommended by the coating material manufacturer and shall be identified by the product number or generic formulation.			
2.6 TOUCH-UP MATERIALS			
2.6.1 Materials for touch-up of damaged areas of surfaces shall be the same as that originally applied. The finish coat and color shall match existing surfaces.			
2.6.2 Touch-up materials shall be provided in premeasured units, unless otherwise specified by the Owner/Engineer.			



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS			
3.0 EXECUTION			
3.1 EXAMINATION			
3.1.1 Prior to the start of work, the Vendor/Contractor shall examine all surfaces to be coated to determine their acceptability for the specified work. If the surfaces are found to be unacceptable, the Vendor/Contractor shall immediately notify the Owner/Engineer in writing and shall not commence work until correction action is completed and the surfaces are approved by the Owner/Engineer.			
3.1.2 The Coatings Contractor is responsible for verifying that the surface is in the proper condition for coating. Contractor shall check that the surfaces meet the requirements before commencing coating preparation work.			
A. The tank shall be fabricated or upgraded to meet the requirements outlined in NACE RP0178-89 "Design Fabrication and Surface Finish of Metal Tanks and Vessels to be Lined for Immersion Service".			
B. All weld spatter and sharp protrusions shall be ground smooth. All sharp outside corners and edges shall be rounded to at least a 1/8-inch radius.			
C. All welds must be continuous. No skip welding is permitted. All existing skip welds shall be upgraded to continuous welds.			
D. All welding shall be complete prior to surface preparation.			
3.2 PREPARATION			
3.2.1 The surface profile of the steel cleaned by blasting shall be as specified in Appendix A.			
3.2.2 The abrasive mixture and the compressed air shall be clean, dry, and oil-free. Traps, in addition to oil and water extractors mounted on the compressor, shall be used.			
3.2.3 Prior to blast cleaning, contamination shall be removed from the steel surfaces. Oil and grease shall be removed by solvent cleaning in accordance with SSPC-SP 1.			
3.2.4 Blast cleaning shall not be performed in the immediate area where coating or curing of coated surfaces is in progress. All surfaces and equipment which are not to be coated shall be suitably protected from blast cleaning.			
3.2.5 Burrs, slivers, scabs, and weld spatter which become visible after blasting shall be power tooled to remove these imperfections. Repaired areas shall have the surface profile suitably restored.			



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3.0 EXECUTION (continued)			
3.2.6 If visible rusting occurs it shall be reblasted to remove flash rust.			
3.2.7 After cleaning and immediately before coating, dust shall be removed with compressed air, free of oil and moisture.			
3.2.8 Machined raised face surfaces shall be solvent wiped in accordance with SSPC-SP 1 before the application of machined-surface coating per requirements of MIL-C16173 and shall be protected from damage due to cleaning and coating operations.			
3.2.9 Raised flange mating faces shall be masked off with plywood to protect internal components. The remaining part of the flange face (including bolt holes) shall then be abrasive blasted and coated.			
3.2.10 No coatings are to be applied to field butt welds (2 inches either side of the weld) until after hydrotesting.			
3.3 EQUIPMENT AND MACHINERY			
3.3.1 The Vendor/Contractor shall provide equipment capable of regulating and controlling conditions within the work area to the extent that the temperature of the substrate is always a minimum of 5°F above the dew point. The substrate temperature during coating application and curing shall be maintained between a minimum of 50°F and a maximum of 110°F unless prior authorization is given in writing by the Owner/Engineer.			
3.3.2 Application equipment shall be as recommended by the coating's manufacturer and shall be suitable to apply the coating as specified.			
3.3.3 Equipment air supply lines shall be equipped with traps to remove moisture and oil as close to the point of use as possible.			
3.3.4 Sufficient floodlight or spotlights (explosion proof) shall be used to provide good visibility during abrasive blasting, coating application, and inspection.			
3.3.5 All personnel entering the tank or vessel after abrasive blasting shall wear rubber soled shoes with clean, disposable shoe covers.			
3.3.6 Adequate ventilation shall be provided during all work and for at least four hours after coating application, to keep solvent concentrations within safe, nonexplosive limits. Vapors shall be removed by use of an air eductor, rather than by air blown into the tank.			



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS			
3.0 EXECUTION (continued)			
3.4 ABRASIVE BLASTING			
3.4.1 The abrasive blast nozzle shall be grounded to the tank shell in order to prevent the buildup of electrostatic charges which could cause a spark discharge.			
3.4.2 Areas to be abrasive blasted shall first be cleaned to degree established in API 2015 "Cleaning Petroleum Storage Tanks for Application of Protective Lining" prior to abrasive blasting. Solvent cleaning shall be limited in accordance with SSPC-SP1, to remove all oil, grease, and other contaminants which might affect the integrity of the coating system.			
3.4.3 The abrasive blasted anchor pattern shall be 2.5-3.5 mils. Prior to the start of the blasting, the Contractor shall select an appropriate abrasive and mesh size to attain the specified anchor pattern. The Owner/Engineer may require the Contractor to demonstrate to the Owner/Engineer's satisfaction that the selected abrasive will provide the specified anchor pattern and surface finish. This shall be done by blasting a representative piece of steel, then measuring the anchor pattern using Press-O-Film tape and comparing the blast quality to SSPC-SP5.			
3.4.4 Only grit-type abrasives shall be used. The use of sand is prohibited. The abrasive shall meet all provisions of Federal, State and local regulations. The abrasive shall be used in accordance with the manufacturer's specifications and shall contain no impurities.			
3.4.5 Blasted surfaces shall be brushed, blown, or vacuumed to remove dust, and approval prior to priming.			
3.4.6 Blasted surfaces shall be coated the same day they are blasted and before any visible rusting, discoloration, or other surface contamination occurs. The time before coating can be extended if adequate dehumidification is used.			
3.4.7 No acid washes or other cleaning solutions or solvents, including inhibitive washes intended to prevent rusting, shall be used on metal surfaces after being blasted, unless otherwise approved by Owner/Engineer.			
3.4.8 A minimum of 4 inches around the edge of blasted areas shall be left uncoated if the entire surface to be coated cannot be blasted and coated on the same day. Subsequent blasting shall continue a minimum of 1 inch into the coated surfaces. The rough edge shall then be feather edged by power or hand sanding with heavy grit wheel or sandpaper. The surface to be coated shall be free of loose and/or burnt coating.			



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS			
3.0 EXECUTION (continued)			
3.4.9 Blasting shall be accomplished so that previously coated surfaces are not contaminated by abrasive or rust.			
3.4.10 Any surface laps, scabs, or seams exposed by blasting shall be reported immediately to the Owner/Engineer for corrective action.			
3.4.11 The compressed air used in any cleaning method shall be free of water and oil. Adequate separators or traps shall be provided. The water traps shall be properly maintained and emptied regularly of water and oil. The air supply shall be tested daily for cleanliness using a white cloth test per ASTM D 4285.			
3.5 GENERAL APPLICATION REQUIREMENTS			
3.5.1 Manufacturer's written data sheet directions shall be followed. The Contractor shall have copies of data sheets in accordance with OSHA 29CFR1910.1200 and the Material Safety Data Sheets for each product available at the site where the coating work is being performed. All paints delivered to the jobsite must have proper labeling in accordance with OSHA 29CFR1926.59.			
3.5.2 The Owner/Engineer may require the Contractor to have a technical representative from the coatings manufacturer present to assist and witness the initial application of each coating system.			
3.5.3 The coating manufacturer's recommended precautions regarding toxicity and safe handling of all coating materials shall be followed. Special care shall be observed to avoid fire hazards.			
3.5.4 Areas which may become inaccessible or difficult to coat after erection shall be coated prior to assembly or erection.			
3.5.5 Surfaces to be coated shall be clean, dust free, and dry before application of any coating and shall meet the specified anchor pattern and surface finish before coated.			
3.5.6 No coating shall be applied on damp surfaces, or when the relative humidity is outside the manufacturer's written recommendation per ASTM E 337, or when the temperature of the surface to be coated is less than 5°F above the dew point.			
3.5.7 Coatings shall not be applied when the ambient temperature is below 50°F. The Contractor shall obtain and follow the manufacturer's recommendations for drying and curing times for all temperatures.			
3.5.8 No coating shall be applied when a temperature of 35°F or lower is forecast within 24 hours of application, unless the coating area is enclosed and heated. If heating is used, the air and coated surface temperature shall be maintained over 50°F. The heaters shall not contaminate the surface with dirt, dust, or combustion products.			



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS

3.0 EXECUTION (continued)

- 3.5.9 All coating materials shall be furnished in the original manufacturer's unopened containers, clearly identifiable, and shall be kept covered, clean, and protected. Materials exceeding, or which may exceed, the manufacturer's recommended shelf life before use shall not be used and shall be removed from the job site.
- 3.5.10 All coating work shall be done in strict compliance with this specification and the coatings manufacturer's data sheets.
- 3.5.11 The coating manufacturer's recommended pot life shall not be exceeded, and when this limit is reached, the spray pot shall be emptied and cleaned, materials properly disposed of and new materials shall be mixed.
- 3.5.12 Multi-component coatings, shall be mixed in the amounts supplied by the coating vendor. No partial kits will be mixed or used.
- 3.5.13 Coatings or coating components shall be thoroughly stirred with an air-driven explosion-proof mixer for such time as necessary to ensure that the pigment, vehicles, and thinners are thoroughly mixed. All mixing shall be done in clean containers, free from traces of grease, other types of coatings, or other contaminants. Containers shall be cleaned regularly to remove partially reacted solids. All containers shall be kept covered to prevent contamination.
- 3.5.14 Each coat shall be applied uniformly and completely over the entire surface according to accepted good coating practice. Care shall be exercised to prevent overspray, spillage, or application of coatings to surfaces for which the coatings are not intended.
- 3.5.15 The linings shall be applied in no fewer than two coats at 6.0-8.0 mils each and a total dry film thickness of 12.0-16.0 mils. The first coat color shall be light gray and the final coat white to allow visual assurance of full coverage of the topcoat. All coating film thicknesses shall be checked, and the coating shall be free of pinholes, voids, bubbles, runs or sags, and other defects. Film thicknesses are to be measured with a wet film gage during application. Film thicknesses shall be verified (checked and maintained) during and after each application of each individual coat. Thickness requirements shall be met with each coat and total thickness shall not be applied in one coat.
- 3.5.16 Dry film thicknesses shall be within the specified range and shall be checked after each coat is applied in accordance with SSPC-PA2. Each coat shall be inspected, and repaired if necessary, before further coatings are applied.



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3.0 EXECUTION (continued)			
3.5.17 Where film thicknesses do not meet specifications and/or defects (holidays) are found, the Contractor shall take corrective action at no additional cost to the project. These corrections shall be in compliance with this specification.			
3.5.18 The coating shall extend at least 1 inch over threaded connections or clips of high alloy.			
3.5.19 All coatings shall be allowed to dry thoroughly and for at least the minimum time recommended by the coatings manufacturer, considering temperature and humidity, before the application of succeeding coats. When a maximum overcoat time is recommended by the coatings manufacturer, it shall not be exceeded before the succeeding coat is applied.			
3.5.20 Prior to the application of any coat, all damage to previous coats shall be repaired.			
3.5.21 Every effort should be made to avoid spills to the ground or by overfilling the drums. Notify the Owner/Engineer immediately of any spills.			
3.6 SPRAY APPLICATION			
3.6.1 In application of the material, one coat shall mean the application of two fully wet passes, each pass overlapping the previous pass by 50% to accomplish uniform hiding. In large areas, the two passes shall be applied at right angles to each other (cross-hatched).			
3.6.2 Atomizing air and pot pressure shall each be regulated to the minimum amount required to properly atomize the material for application without dry spray, runs, or sags.			
3.6.3 Separate regulators shall be used to adjust the pot pressure and the atomization pressure. Each regulator shall be provided with a pressure gage operating properly at all times.			
3.6.4 Airless spray equipment may be used, in lieu of conventional spray equipment. If airless equipment is used an operating pressure relief valve must be installed and reversible spray tips used. Kinked, damaged, leaking or pinholed hoses must be replaced.			
3.6.5 Pots, lines, and spray guns shall be cleaned periodically to remove all partially or fully reacted solids.			
3.6.6 Adequate moisture traps shall be placed at the air supply line at the compressor and at the pressure pot, or other locations as deemed necessary. Traps shall bleed off any water or oil from the air supply.			



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS

3.0 EXECUTION (continued)

3.6.7 Contractor shall train applicators in the proper application technique prior to commencing work. Applicators failing to meet this requirement, to the Owner/Engineer's satisfaction, shall be removed from coating application.

3.7 BRUSH OR ROLLER APPLICATION

3.7.1 Coatings shall be brushed or rolled on all areas which cannot be properly spray coated. Brushes and rollers shall be of the type, style, and quality that will ensure proper application of materials. Brush and roller type shall be approved for use by the coatings manufacturer.

3.7.2 The coating shall be worked into all crevices and corners, and all runs or sags shall be brushed or rolled out.

3.8 WASTE DISPOSAL (jobsite)

3.8.1 All liquid containing paint and solvents must be poured into closed top drums; and these drums must be sealed with bungs when not in use as required by federal, state and local regulatory agencies.

3.8.2 All drums must have a hazardous waste label with the accumulation date.

3.8.3 All empty paint cans must be deposited into a designated rolloff area.

3.8.4 Drums must be picked up for disposal first in first out (FIFO) within 90 days of the accumulation date

3.8.5 Drums containing spent solvents and paint will require weekly inspection.

3.8.6 Any leaking drums must be transferred immediately with notification to Owner/Engineer.

3.9 FIELD QUALITY CONTROL

3.9.1 General

A. The Contractor shall perform all inspection necessary to assure that surface preparation and coating applications comply with the requirements of this Specification. All work shall be subject to Owner/Engineer inspection. All records shall be kept current and shall be submitted to the Owner/Engineer upon demand, or at least weekly, and at the completion of the job for verification. The Contractor shall submit his proposed daily inspection report as specified under section on submittals.



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS

3.0 EXECUTION (continued)

B. The Owner's inspector shall be given at least four (4) hours' notice prior to the start of any surface preparation to include:

- Following surface preparation and immediately prior to coating application.
- Following the application and curing of each coat.
- After final inspection and sign-off.

C. The Owner's inspector shall be the final judge of the acceptability of surface preparation and coating application.

D. If the Owner's inspector believes the coatings work is not being performed in accordance with this Specification, he has the authority to stop work until compliance is attained.

E. The coating manufacturer's representative shall have access to the work site during the progress of the work, to perform any inspection and testing deemed necessary to ensure that the coatings are properly applied.

F. The cleanliness of each compressed air supply shall be verified daily by blasting without sand or coating onto a white cloth for 20 seconds. If oil or water appears on the cloth, all traps and separators shall be blown down until subsequent 20-second cloth tests show no more oil or water.

G. Recirculated metallic abrasives if used shall be tested for oil contamination at least twice per shift by the immersion of a small amount of abrasive in a vial of water which is shaken vigorously. If any oil floats to the surface, the abrasive shall be discarded. Also, dust must be removed from recirculated abrasives to meet environmental regulations and to improve cutting efficiency.

3.9.2 Surface Preparation Inspection

A. Blasted surfaces shall be inspected by the following methods to verify that the specified surface preparation has been achieved.

B. Verify the anchor pattern using Testex Inc. "Press-O-Film" tape or approved equal. The measurements shall be recorded on the Contractor's Daily Inspection Report and submitted to the Owner/Engineer.



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS

3.0 EXECUTION (continued)

C. Verify the degree of cleanliness by comparison to the SSPC-SP5. Results shall be recorded on Daily Inspection Report and submitted to the Owner/Engineer.

3.9.3 Lining Application Inspection

A. Coatings shall be inspected by the following methods to verify that the specified quality and thickness have been achieved.

B. At the beginning of each day's operation and immediately prior to coating, the ambient temperature, the temperature of the surface to be coated, the surface preparation, cleanliness and anchor pattern (for surfaces to be primed that day), the relative humidity, and the dew point shall be measured and recorded. Verify that no moisture is present on the surface to be coated. These items shall be recorded on the daily inspection form and submitted to the Owner/Engineer.

C. Dry film thicknesses shall be measured with a "mikrotest" magnetic film thickness gauge or approved equal. Dry film measurement shall be performed in accordance with SSPC-PA-2. The dry film thickness gauge shall be calibrated at the beginning of construction coating work, and then at least weekly or whenever the Owner/Engineer requests recalibration. Calibration shall be made by comparison with the dry film thickness measured on known standards such as National Bureau of Standards' Calibration Standards for Coating Thickness Gages. Dry film thicknesses shall be recorded on the daily inspection form and submitted to the Owner/Engineer for each coat as well as for the total thickness of each finished coating system.

3.9.4 Inspection and Repair of Defects

A. The completed coating shall be checked for pinholes, holidays, and thin spots. For coatings up to 15 mils DFT, a 67-volt, wet sponge-type detector (using a suitable wetting agent) shall be used. For thicker films, a high voltage spark-type apparatus set at 100 volts/mil of thickness shall be used.

B. Areas containing holidays shall be repaired to coating manufactures written instructions and retested for holidays. Detected holidays, correction, and final holiday-free inspection shall be recorded and submitted to the Owner/Engineer.



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SPECIFICATION FOR INTERIOR LINING SYSTEM FOR STEEL STORAGE TANKS

APPENDIX A

I. Lining Matrix:

1A. **Valspar Corp**

Surface Preparation: SSPC-SP-5 "White Metal Blast"
Anchor Profile: 2 1/2 - 3.0 mils
Primer: V78-D-7PR (Light Buff) 4.0 - 6.0 mils dft
Finish: V78-W-3PR (White) 4.0 - 6.0 mils dft

Note: VOC 3.3 lb/gal or 396 grams/liter

1B. **Ameron Corp.**

Surface Preparation: SSPC-SP-5 "White Metal Blast"
Anchor Profile: 2 1/2 - 3.0 mils
Primer: Amercoat 90 HS (Pearl Gray) 4.0 - 6.0 mils dft
Finish: Amercoat 90 HS (White) 4.0 - 6.0 mils dft

Note: VOC 2.7 lb/gal or 323 grams/liter

1C. **International Protective Coating**

Surface Preparation: SSPC-SP-5 "White Metal Blast"
Anchor Profile: 2 1/2 - 3.0 mils
Primer: Interline 785HS (Beige) 4.0 - 6.0 mils dft
Finish: Interline 785HS (White) 4.0 - 6.0 mils dft

Note: VOC1.53 lb/gal. or 183 grams/liter

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Jacobs Engineering Group, Inc.
Central Region Houston, Texas



AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K-784-00


NO. 09900

SPECIFICATION FOR
SHOP AND FIELD COATING

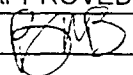
BY	APPROVED	ISSUE DATE
BW		8/26/96

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1.0 GENERAL

1.1 DESCRIPTION

1.1.1 This specification covers the minimum requirements for materials, surface preparation, application, inspection and quality control of protective coatings, specifically atmospheric service for plant facilities and equipment to be shop and/or field painted. The items and surfaces to be coated shall be done in accordance with paint systems defined in Appendix A.

1.1.2 Those components which are "manufacturer's standard" items such as pumps, compressors, motors, switchgear, valves, and fittings may be exempt and receive a Vendor's standard coating system, only with prior approval of the Owner/Engineer.

1.1.3 Items Included

- A. Surface preparation, furnishing materials and the application of protective coatings to all surfaces shall be in accordance with Appendix A.
- B. Inspections and tests.
- C. Protection of coated surfaces.
- D. Environmental controls necessary to provide the application and curing conditions required.
- E. Erection marking.
- F. Touch-up and repair of defective or damaged coated surfaces.

1.1.4 Related Items Not Included

The following surfaces shall not be painted:

- A. Surfaces within two inches of field butt welds until hydrostatic pipe testing has been conducted, unless otherwise specified.
- B. Name and instruction plates, etc.
- C. Insulation jacketing.



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SPECIFICATION FOR SHOP AND FIELD COATING

1.0 GENERAL (continued)

D. Stainless steel surfaces. Protective coating is required if item is insulated per Appendix A Paint System # 3

E. Galvanized surfaces, with exception to insulated items or for color coding as required for safety reasons.

F. Polished and machine surfaces (raised face flange faces).

G. Nonmetallic and nonferrous surfaces.

H. Interior surfaces of equipment.

I. Internal linings, concrete or structures.

J. All galvanized structural steel including ladders, cages, platforms, stairways and grating.

K. Instrument gauges, levels glass indicators, name tags, and valves stems.

1.2 RELATED SECTION

Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01300	Submittals

1.3 REFERENCE STANDARDS (LATEST EDITION)

ANSI Z53.1	Safety Color Code for Marking Physical Hazards
ASTM A 123	Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM D 4285	Indicating Oil or Water in Compressed Air
ASTM D 4417	Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM E 337	Test for Relative Humidity by Wet-and-Dry-Bulb Psychrometer
Feb. Std. 595a	Colors



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SPECIFICATION FOR SHOP AND FIELD COATING

1.0 GENERAL (continued)

OSHA 29CFR1910.144	Safety Color Code
OSHA 29CFR1910.1200	Hazard Communications Standard
OSHA 29CFR1926.59	Labeling of Hazardous Materials
NAPCA TGF-3	National Association of Pipe Coating Application Specifications and Plant Coating Guide
SSPC AB 1	Abrasive Specification No. 1 Mineral and Slag Abrasives
SSPC SP 1	Solvent Cleaning
SSPC SP 2	Hand Tool Cleaning
SSPC SP 3	Power Tool Cleaning
SSPC SP 5	White Metal Blast Cleaning
SSPC SP 10	Near White Blast Cleaning
SSPC SP 11	Power Tool Clean to Bare Metal
SSPC Vis 1-89	Visual Standards for Abrasive Blast Cleaned Steel
SSPC PA 2	Measurement of Dry Paint Thickness with Magnetic Gauges

1.4 SUBMITTALS

- 1.4.1 All documentation shall be submitted in accordance with Section 01300, Submittals.
- 1.4.2 A listing of coating systems and material to be used on each item, shall be in accordance with this specification. Components, or pieces of equipment shall be submitted for review and approval. This shall include the Vendor/Contractor written proposed system of work which identifies the specific products by manufacturer and catalog number.
- 1.4.3 For paint systems selected from this specification, the Vendor/Contractor shall provide written procedures for storage, handling, surface preparation, environmental control, application, touch-up and repair, curing, and inspection. This shall be submitted for review and approval to proceed prior to use. Conflicts, if any, between the coating manufacturer's recommendations and this specification shall be noted in writing to the Owner/Engineer for resolution.
- 1.4.4 The Vendor/Contractor shall submit a check list that identifies items to be coated by tag number and name, which should include pertinent information, as follows:



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SPECIFICATION FOR SHOP AND FIELD COATING			
1.0 GENERAL (continued)			
A. Insulated/Uninsulated			
B. Fireproofed (Skirts, Saddles, etc.)			
C. Type Metal (Carbon Steel/Low Carbon Alloy)			
D. Extent and Condition of Shop and/or Field Coating			
1.4.5 The Vendor/Contractor proposed cleaning and coating verification forms for daily inspection records shall be submitted for review. Following review and acceptance of this form, a completed form shall be submitted for each item coated.			
1.4.6 Vendor/Contractor shall submit the manufacturer's volatile organic compound (VOC) data sheets and Manufacturers Safety Data Sheet (MSDS) for review.			
1.5 DEFINITIONS			
A. "OWNER" - the OWNER or the Owner's representative.			
B. "VENDOR/CONTRACTOR" - the equipment fabricator, supplier, or subcontractor.			
C. "ENGINEER" - Design Engineer			
1.6 SHIPPING, HANDLING AND STORAGE			
1.6.1 Coating materials shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number, and date of manufacture. Containers which are damaged shall not be used.			
1.6.2 The material shall be handled and stored in accordance with the manufacturer's latest published instructions and shall be protected from damage, moisture, direct sunlight, and temperatures below 40°F or above 90°F.			
1.6.3 The coating materials shall be used within the manufacturer's recommended shelf life.			
1.6.4 Containers of coatings or components shall not be opened unless for immediate use.			
1.6.5 All usable paint cans and solvent containers must be kept in a designated place and must be marked clearly for good housekeeping practice.			



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SPECIFICATION FOR SHOP AND FIELD COATING

3.0 EXECUTION (continued)

3.2.5 Burrs, slivers, scabs, and weld spatter which become visible after blasting shall be power tooled to remove these imperfections. Repaired areas shall have the surface profile suitably restored.

3.2.6 If visible rusting occurs it shall be reblasted to remove flash rust.

3.2.7 After cleaning and immediately before coating, dust shall be removed with compressed air, free of oil and moisture.

3.2.8 Machined raised face surfaces shall be solvent wiped in accordance with SSPC-SP 1 before the application of machined-surface coating per requirements of MIL-C16173 and shall be protected from damage due to cleaning and coating operations.

3.2.9 Raised flange mating faces shall be masked off with plywood to protect internal components. The remaining part of the flange face (including bolt holes) shall then be abrasive blasted and coated.

3.2.10 No coatings are to be applied to field butt welds (2 inches either side of the weld) until after hydrotesting.

3.2.11 Steel Which Has Been Shop Primed Only

After erection and/or installation but before top coating, items previously primed shall be examined for damage and for unprimed area. All oil and grease shall first be removed in accordance with SSPC-SP 1. Unprimed and damaged areas shall be power tool cleaned in accordance with SSPC SP 11 "Power Tool Cleaning to Bare Metal", and touched up with original primer.

3.2.12 Galvanized Steel

Damaged hot-dip galvanized steel shall be repaired as follows:

A. Clean the damage area per SSPC-SP 3.

B. Touch-up with an Organic Zinc Rich Epoxy (Paint System # 1 - first coat P-2 only).

C. Refer to ASTM A-123 for additional repair procedures.



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SPECIFICATION FOR SHOP AND FIELD COATING

3.0 EXECUTION (continued)

3.3 EQUIPMENT AND MACHINERY

3.3.1 Equipment shall be capable of producing the specified environment for performance of the work according to the schedule accepted by the Owner/Engineer.

3.3.2 Application equipment shall be as recommended by the coating manufacturer and shall be suitable to apply the coating as specified.

3.3.3 Equipment air supply lines shall be equipped with traps to remove moisture and oil as close to the point of use as possible.

3.4 INSTALLATION OF COATINGS

3.4.1. Mixing, applying, and curing of the coating material shall be in accordance with the manufacturer's latest published instruction and the requirements specified herein. When multiple component units are mixed, each component shall be mixed separately prior to the mixing of the combined materials. Only complete kits shall be mixed, no partial kits will be allowed at any time.

3.4.2 Coating materials shall be thoroughly mixed until they are smooth and free from lumps, then strained through a 30 mesh or finer screen. Material shall be agitated to keep the solids in suspension if necessary (i.e., inorganic zinc coatings must be mechanically agitated at all times).

3.4.3 The cleaned surface shall be coated before any visible rust forms on the surface. No coating material shall be applied closer than 6 inches from adjacent non-cleaned surfaces.

3.4.4 The application of the coating shall be performed only when the atmospheric conditions meet the parameters specified in Paragraph 3.1.1. The relative humidity shall not exceed the published limits established by the coatings manufacturer.

3.4.5 Enclosures to permit coating of surfaces during inclement weather may be used, provided the atmospheric conditions specified are maintained throughout the coating and curing periods.

3.4.6 Over-coats/topcoats shall be applied within the manufacturer's minimum and maximum recoat times. Dry film thickness of each coating shall be in accordance with Appendix A, or manufacturer's recommendation, whichever is greater.



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SPECIFICATION FOR SHOP AND FIELD COATING

3.0 EXECUTION (continued)

3.4.7 Runs, sags, voids, drips, overspray, loss of adhesion, blistering, peeling, mudcracking, inadequate cure, or rusting of the substrate shall not be permitted.

3.4.8 Items shall be coated in accordance with Appendix A. The color of succeeding coats shall vary slightly from the color of finish color. Damaged coatings shall be retouched before succeeding coats are applied. Finish colors shall be in accordance with Appendix A.

3.4.9 Flanges, nozzles, clips, manways, saddles and other attachments which protrude through the insulation shall be considered uninsulated and shall be painted according to the guidelines for uninsulated surfaces outlined in Appendix A.

3.4.10 Field finish coat shall be applied after the installation and erection of the item.

3.4.11 Damaged shop-finish of materials and equipment shall be touched-up after installation, matching the original color, gloss, and thickness of finish. Reasonable shipping damages should be expected and touched up. This work shall be performed at the field Contractor's expense.

3.4.12 Every effort should be made to avoid spills to the ground or by overfilling the drums. Notify the Owner/Engineer immediately of any spills.

3.5 REWORK

3.5.1 Touch-Up

A. Coated surface within the scope of this standard that are damaged during assembly or handling shall be repaired in accordance with procedures accepted by the Owner.

B. The surface profile shall be restored to meet the specified surface preparation requirements for cleanliness and profile.

C. Precautions shall be taken to protect adjacent coated areas from damage caused by local abrasive blasting.

D. Power tool cleaning shall be done using requirements of SSPC SP11.



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SPECIFICATION FOR SHOP AND FIELD COATING

3.0 EXECUTION (continued)

3.6 WASTE DISPOSAL (JOBSITE)

3.6.1 All liquid containing paint and solvents must be poured into closed top drums; and these drums must be sealed with bungs when not in use, as required by the Federal, State and Local regulatory agencies.

3.6.2 All drums must have a hazardous waste label with the accumulation date.

3.6.3 All empty paint cans must be deposited into a designated area.

3.6.4 Drums must be picked up for disposal first in first out (FIFO) within 90 days of the accumulation date.

3.6.5 Drums containing spent solvents and paint will require weekly inspection.

3.6.6 Any leaking drums must be transferred immediately with notification to Owner/Engineer.

3.7 FIELD QUALITY CONTROL

3.7.1 General Requirements

A. The following steps shall be subject to inspection by Owner/Engineers:

- Following surface preparation and immediately prior to the coating application.
- Following the application and curing of each coat.
- After final inspection and sign-off, in accordance with the project requirements.

B. The Vendor/Contractor shall furnish the necessary testing and inspection instruments, properly calibrated and maintained. Such equipment shall be available for use by the Owner/Engineer in conducting surveillance of the work.



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SPECIFICATION FOR SHOP AND FIELD COATING

3.0 EXECUTION (continued)

C. Prior to using compressed air, the quality of the air downstream of the separator shall be tested in accordance with ASTM D 4285. The test shall be performed at the beginning of each shift and at not less than four hour intervals. The air shall be used only if the blotter test indicates no visible contamination, oil, or moisture.

D. Any defects disclosed by inspection shall be reinspected after correction.

3.7.2 Surface Preparation Inspection

A. The temperature, dew point, and relative humidity shall be determined using a sling psychrometer in accordance with the instructions outlined in ASTM E 337. Readings are required at the start of work and every four hours or at other time intervals approved in writing by the Owner/Engineer. Alternatively, continuous monitoring shall be performed using systems established and/or accepted by Owner/Engineer.

B. Blast cleaned surfaces shall be compared with SSPC-VIS 1-89, visual standards. The anchor pattern profile depth shall be verified in accordance with ASTM D 4417, or using replica tape with spring micrometer.

C. A grease-free chalk shall be used to mark local areas which do not meet specified standards.

D. Shop recirculated shot and grit used for abrasive cleaning shall be tested for the presence of oil by immersing in water and checking for oil flotation. Tests shall be made at the start of blasting, every four hours thereafter, and at the end of blasting. If oil is evident, contaminated abrasive shall be replaced with clean abrasive and retested before proceeding.

3.7.3 Coating Inspection

A. Surface temperature and humidity readings shall be taken prior to application of each coat. The work shall not proceed if the ambient temperature parameters are outside the requirements of this standard. If more stringent, the Coating Manufacturer's requirements shall dictate. The substrate temperature shall be at least 5°F above the dew point temperature.

B. The dry film thickness shall be tested with a Mikro-test FILM gauge or an accepted equivalent. The testing method shall be in accordance with SSPC-PA 2.



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SPECIFICATION FOR SHOP AND FIELD COATING

3.0 EXECUTION (continued)

C. The FILM coating shall be visually inspected for defects such as overspray, runs, sags, mud cracking, inadequate cure, and lack of adhesion. Mud cracking must be removed by reblasting. The Vendor/Contractor shall repair all defects according to the touch-up and repair procedures accepted by the Owner/Engineer.

D. Inspection equipment required for quality assurance is listed below:

- Sling Psychrometer
- Surface Thermometer
- Dry Film Gauge-Magnetic Gauge
- Wet Film Gauge
- Profile Comparator
- Testex Press-O-Film (Replica Tape & Spring Micrometer)



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SPECIFICATION FOR SHOP AND FIELD COATING

APPENDIX A GENERIC AND SPECIFIC PRODUCTS, COATING SYSTEMS/MATRIX

I. Paint System Selection Matrix

The coating selection matrix can be used to determine a specific coating system based on the design criteria and service conditions for any given item.

<u>MATERIAL TYPE</u>	<u>OPERATING TEMP.</u>	<u>INSULATED</u>	<u>UNINSULATED</u>
CARBON STEEL	Up to 250°F	4	1
	251°F -500°F	5	5
GALVANIZED	Up to 220°F	2	3 (note 4)
MFGR. STD. PAINT SYST. UPGRADE	Up to 220°F	4	3
BULK PIPE: Underground	Up to 275°F	6	6

- Notes:
1. Structural steel shall be galvanized in accordance with ASTM A-123.
 2. Bulk pipe shall receive complete paint system in shop.
 3. All major equipment shall receive complete paint system in shop. (Vessels, towers, exchangers, etc.).
 4. Coating of uninsulated galvanized steel shall be for color coding and safety purposes only.

II. Coating Systems Description

Coating Systems Description represents each individual generic type paint that makes up the total coating systems also includes operating temperature range.



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SPECIFICATION FOR SHOP AND FIELD COATING

II. Coating Systems Description (continued)

PROJECT PAINT SYSTEM	(PAINT NUMBER)			MATERIALS TEMPERATURE RANGE
	COAT 1	COAT 2	COAT 3	
1	P-2		P-7	Up to 200°F
2	P-8		P-3	Up to 200°F
3	P-4		P-7	Up to 200°F
4	P-4		P-4	Up to 200°F
5	P-1		P-5	Up to 500°F
6	P-6		P-6	Up to 250°F

III. Generic Paint Types and Requirements

These Generic Paint Types are identified and make up the coating systems under Item II above, which in turn make up the coating selection matrix under Item I.

PAINT NO.	GENERIC PRODUCTS	ANCHOR	SSPC SP	D.F.T. MIN/MAX (EA. COAT)
P-1	Inorganic Zinc	1.5-2.5	5	2.0-4.0
P-2	Organic Zinc Rich Epoxy Primer	1.5-2.0	10	3.0-5.0
P-3	H.B. Epoxy Polyamide	n/a	n/a	4.0-6.0
P-4	Surf. Tol. Epoxy	2.0-3.0	6	4.0-6.0
P-5	Silicone Acrylic	n/a	n/a	1.0-2.0
P-6	Coal Tar Epoxy	2.5-3.0	6	4.0-6.0
P-7	Aliphatic Polyurethane	n/a	n/a	1.5-2.5
P-8	Polyamide Epoxy Primer	1.0-1.5	6	2.0-3.0

- Notes:
1. Only first coat requires anchor profile and SSPC SP cleanliness.
 2. Repairs in field shall be per SSPC SP11.



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SPECIFICATION FOR SHOP AND FIELD COATING

IV. Acceptable Paint Manufacturers

PAINT

NO.	CARBOLINE	(VOC)	VALSPAR	(VOC)	DEVOE	(VOC)
P-1	Carbozinc 7WB	(0)	13-F6	(0)	302H	(2.3)
P-2	858	(2.5)	13F4	(2.4)	303H	(2.4)
P-3	893	(1.6)	V-89 Series	(2.6)	224HS	(1.8)
P-4	890	(1.8)	V-75 Series	(2.3)	Bar Rust 236	(1.4)
P-5	1248	(4.5)	V37F209	(3.4)	HT-4	(4.5)
P-6	Bitumastic 300M	(2.1)	64J5	(1.9)	Devlar 5A	(2.2)
P-7	134 HS	(2.4)	54 Series	(2.1)	Devthane37 9	(2.6)
P-8	893	(1.6)	V-75 Series	(2.3)	224HS	(1.8)

- Notes:
1. Coatings must meet Volatile Organic Compound (VOC) of 2.8 lbs per gal. or less. (material must meet Massachusetts VOC requirements.)
 2. P-5 is a high heat coating and exempt from the 2.8 lb. per gal. VOC requirement.

V. Color Coding Description - Final Coat

- | | |
|--|--------------------------|
| 1. Structural Steel, (Non-Galvanized) Walkways, Stanchions, Framing. | ANSI #70 GRAY |
| 2. Pipe below 250°F. | ANSI #70 GRAY |
| 3. Pipe above 251°F, Stack, Heater, Manifold, Muffles, Pumps. | ANSI #70 GRAY |
| 4. Drums, Vessels, and Exchangers "Uninsulated". | ANSI #70 GRAY |
| 5. Compressor, Pumps, Machinery. | ANSI #70 GRAY |
| 6. Architectural Steel Framing, Doors, Windows, Trim, Metal Doors. | ANSI #70 GRAY |



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SPECIFICATION FOR SHOP AND FIELD COATING

V. Color Coding Description - Final Coat (continued)

7.	Storage Tanks, Ladders, Roofs, and Associated Piping to First Mating Flange.	ANSI #70 GRAY
8.	Towers and Exposed Insulated, Connections, Heaters - Radiant, Convection and Transition Section.	ANSI #70 GRAY
9.	Electrical Switchgear	White
10.	Galvanized Steel - Coated.	Aluminum
11.	OSHA Safety Colors	

Safety Red
Safety Yellow
Safety Orange
Safety Blue
Safety Green
Black

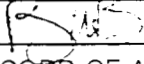

Note: Each coat (Coat 1, Coat 2, Coat 3) shall be of a contrasting color, with color for final coat as specified above.

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				SPECIFICATION FOR ARCHITECTURAL PAINTING	
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1.0 GENERAL

1.1 Description

A. This Section describes the materials, methods and requirements for the painting of architectural items, including the interior and exterior of buildings, structural steel, and concrete.

B. Field painting will not be required on factory-finished items of aluminum, brass, bronze and other non-ferrous metals and steel hot-dip galvanized by ASTM A 123, unless designated on the Drawings.

C. Field painting will not be required on wall and ceiling surfaces not exposed to view.

1.2 Related Sections

A. Section (08110) Metal Doors and Frames

B. Section (09250) Gypsum Board

C. Section (13121) Pre-Engineered Building

1.3 Quality Assurance

A. References (Latest Edition)

1. SSPC (Steel Structures Painting Council)

a. SP-1: Solvent Cleaning

b. SP-2: Hand Tool Cleaning

c. SP-3: Power Tool Cleaning

d. SP-6: Commercial Blast Cleaning

2. ASTM A 123: Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip.



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**SPECIFICATION FOR
ARCHITECTURAL PAINTING**

1.0 **GENERAL** (continued)

B. **Qualification of Painters**

Use only qualified journeymen painters for the mixing and application of paint.

C. **Material Quality:**

Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1.4 **Submittals**

A. **Color Cards**

1. Prepare at the jobsite sample panels for each color selected for approval by the Owner.

a. The finished work shall match the approved sample panels.

b. Approval of advance samples shall not be construed as a total guarantee of acceptance of the work.

2. Submit paint manufacturer's technical product data.

3. Samples for initial color selection in the form of manufacturer's color charts

1.5 **Product Delivery and Storage**

A. Paints shall be delivered to the site in unopened, unbroken, original containers of not larger than 5 gallon capacity, each bearing the manufacturer's label. The label shall specify the manufacturer's name, trade name, batch number, quantity, color, date of manufacture and directions for use, all of which shall be plainly legible.

B. Storage of paints and paint materials shall be restricted to the locations directed.



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**SPECIFICATION FOR
ARCHITECTURAL PAINTING**

1.0 **GENERAL** (continued)

1.6 **Environmental Requirements**

A. Temperature: Surfaces to be painted shall be within the following temperature range, except that the temperature shall not exceed the manufacturer's written recommendations.

1. Vinyls, polyurethanes and epoxies - between 60 degrees F and 120 degrees F.

2. Alkyd enamels, latexes and zinc rich primers - between 40 degrees F and 120 degrees F.

B. Humidity: Surfaces to be painted shall be dry and at least 5 degrees F above the dew point (see Appendix B), except that the relative humidity shall not exceed the manufacturer's written recommendations.

C. Interior paints may be applied in any season provided the surfaces are dry and the temperature is within the limitation specified.

D. Adequate ventilation shall be provided, and sufficient time shall be allowed between coats to assure thorough drying.

1.7 **Protection**

A. Drop cloths, building paper and other protective measures shall be used to protect adjacent work, machinery, equipment and apparatus from damage or defacement, and in particular, surfaces within storage and preparation area. Damage and defacement shall be repaired in an approved manner at no additional cost to the Owner.

B. The areas being painted shall be protected from dust until freshly painted surfaces have thoroughly dried.

C. Place waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from site.

D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned and replaced on completion of work in each area. Do not



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SPECIFICATION FOR ARCHITECTURAL PAINTING

2.0 PRODUCTS

use solvent to clean hardware that may remove permanent lacquer finish.

2.1 Materials

- A. The attached Painting Schedules (Appendix A) are an integral part of this Section, and identify the paint to be used by type of material and exposure (exterior or interior). The number of coats and dry film thickness within the range specified shall be applied before Contract completion. Any factory primed surfaces shall be completed by field application of the remaining coats.
- B. Paint shall be ready-mixed, except field catalyzed coatings of types and brands specified in this Section or approved by the Owner's representative. The term "paint" includes enamels, emulsions, sealers, fillers and other coatings, organic or inorganic, whether used as prime, intermediate or finish coats. Pigments shall be fully ground to maintain a soft paste consistency, capable of being readily and uniformly dispersed to a complete homogeneous mixture.
- C. Paint accessory materials including tints, thinners and other materials not specifically indicated herein but required to achieve the finished specified, shall be approved by the paint manufacturer.
- D. Paints shall have good flowing and brushing properties and shall dry or cure free of streaks or sags.
- E. All paint for each service shall be supplied by the same manufacturer.

3.0 EXECUTION

3.1 Inspection

- A. Thoroughly examine surfaces scheduled to be painted prior to commencement of work. Report in writing to the Owner's representative any condition that may potentially affect proper application. Do not commence until such defects have been corrected.



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**SPECIFICATION FOR
ARCHITECTURAL PAINTING**

3.0 **EXECUTION** (continued)

B. Start of painting will be construed as the applicator's acceptance of surface and conditions within a particular area.

3.2 **Preparation**

A. Remove mildew by scrubbing with solution of trisodium phosphate and bleach. Rinse with clean water and allow surface to dry completely.

B. Structural Steel Not Galvanized: Clean in accordance with SSPC-SP 6, "Commercial Blast Cleaning", with a maximum surface profile of 2.0 mils.

C. Shop Primed Steel: Marred or abraded surfaces shall be cleaned in accordance with SSPC-SP 2, "Hand Tool Cleaning", or SSPC-SP 3, "Power Tool Cleaning". Touch up with the same material as the shop coat prior to painting of surfaces.

D. Galvanized Steel and Aluminum: Clean in accordance with SSPC-SP 1, "Solvent Cleaning".

E. Ferrous Metal (Interior-Non-Corrosive): Clean in accordance with SSPC-SP 2, "Hand Tool Cleaning", or SSPC SP-3, "Power Tool Cleaning".

F. Wood: Wipe off dust and grit prior to priming. Spot coat knots, pitch streaks and sappy sections with sealer. Fill nail holes and cracks after primer has dried and sand between coats.

G. Gypsum Board: Remove contamination from surfaces and prime to show defects, if any. Paint after defects have been remedied.

H. Concrete and Concrete Masonry Units: Repair before painting. Dirt, fungus, grease and oil shall be removed prior to painting by washing with a solution consisting of 2 pounds trisodium phosphate to each gallon of hot water (160°F). Rinse well and allow to thoroughly dry.

3.3 **Application**

A. Apply each coat at proper consistency. Coats shall produce an even film of uniform thickness within the limits specified in this Section.



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

3.0 EXECUTION (continued)

- B. Finished surfaces shall be free from runs, drops, ridges, waves, laps, sags and unnecessary brush marks.
- C. Edges, corners, crevices, welds and such other conditions shall receive special attention to insure that they will receive an adequate thickness of paints.
- D. Allow each coat of paint to dry before the following coat is applied, unless directed otherwise by manufacturer.
- E. Succeeding coats of the same type and color shall vary sufficiently from the color of the preceding coat to permit ready identification. Primers and intermediate coats shall be tinted to approximately the tint of the finish coat.
- F. Number of coats indicated are minimum. Complete coverage is required. Provide additional coats to areas which do not show complete coverage with the specified coats.
- G. Non-skid surfaces, when specified on the Drawings, shall be obtained by applying sharp, dry silica sand by shaker to the finish coat while it is still wet. The loose excess sand shall be swept off after a suitable drying interval.

3.4 Patching

- A. Damaged painting shall be retouched before applying the succeeding coats. Finished surfaces shall be even and free from defects.

3.5 Cleaning

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered.
- B. During progress of work keep premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.



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SPECIFICATION FOR ARCHITECTURAL PAINTING			
4.0 <u>ATTACHMENTS</u>			
<u>Appendix A</u> + <u>Painting Schedule</u>			
<u>System</u>	<u>Service</u>		
1	Structural Steel Not Galvanized (Exterior and Interior)		
2	Galvanized Steel and Aluminum (Exterior and Interior)		
3	Ferrous Metals not Galvanized (Interior - Non-Corrosive)		
4	Wood (Exterior)		
5	Wood (Interior)		
6	Gypsum Board - Enamel Coating (Interior)		
7	Gypsum Board - Epoxy Coating (Interior)		
8	Concrete Masonry Units - Epoxy Coating (Exterior and Interior)		
9	Concrete Masonry Units - Enamel Coating (Interior)		
Appendix B Maximum Relative Humidity Chart			



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SPECIFICATION FOR ARCHITECTURAL PAINTING															
<p style="text-align: center;"><u>APPENDIX A</u> <u>SYSTEM 1</u></p> <p style="text-align: center;">STRUCTURAL STEEL NOT GALVANIZED EXTERIOR AND INTERIOR</p>															
<table border="1"><thead><tr><th>MANUFACTURER</th><th>PRIME</th><th>INTERMEDIATE</th><th>FINISH</th></tr></thead><tbody><tr><td>Carboline</td><td>Carbo Zinc 11 HS 2.0 - 3.0 mils</td><td>890 4.0 - 6.0 mils</td><td>134 HS 1.5 - 2.5 mils</td></tr><tr><td>PPG</td><td>97-673 Series Metalhide 1001 2.5 - 3.5 mils</td><td>97-130 Series 4.0 - 6.0 mils</td><td>97-800 Series 1.5 - 2.0 mils</td></tr></tbody></table>				MANUFACTURER	PRIME	INTERMEDIATE	FINISH	Carboline	Carbo Zinc 11 HS 2.0 - 3.0 mils	890 4.0 - 6.0 mils	134 HS 1.5 - 2.5 mils	PPG	97-673 Series Metalhide 1001 2.5 - 3.5 mils	97-130 Series 4.0 - 6.0 mils	97-800 Series 1.5 - 2.0 mils
MANUFACTURER	PRIME	INTERMEDIATE	FINISH												
Carboline	Carbo Zinc 11 HS 2.0 - 3.0 mils	890 4.0 - 6.0 mils	134 HS 1.5 - 2.5 mils												
PPG	97-673 Series Metalhide 1001 2.5 - 3.5 mils	97-130 Series 4.0 - 6.0 mils	97-800 Series 1.5 - 2.0 mils												



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 2

GALVANIZED STEEL AND ALUMINUM

EXTERIOR AND INTERIOR

MANUFACTURER	PRIME	INTERMEDIATE	FINISH
Carboline	Rustbond Penetrating Sealer 1.5 - 2.0 Mils	None	134 HS 1.5 - 2.5 mils
PPG	97-148 Series Pitt-Guard D-T.R 5.0 - 7.0 mils	None	97-800 Series 1.5 - 2.0 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 3

FERROUS METALS NOT GALVANIZED

INTERIOR - NON-CORROSIVE

MANUFACTURER	PRIME	FINISH
Carboline	3358 2.0 - 4.0 mils	3359 2.0 - 4.0 mils
PPG	6-208 Speedhide 1.5 - 2.0 mils	6-90 Series 1.6 - 1.7 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 4

WOOD

EXTERIOR

MANUFACTURER	PRIME	FINISH
Carboline	Multibond - 120 2.0 - 4.0 mils	3359 2.0 - 4.0 mils
PPG	6-9 Speedhide (Southern Version) 2.2 mils	1-Line Sun-Proof (Southern Version) 2.2 - 2.5 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 5

WOOD

INTERIOR

MANUFACTURER	PRIME	FINISH
Carboline	Multibond - 120 2.0 - 4.0 mils	3359 2.0 - 4.0 mils
PPG	6-6 Speedhide 1.4 - 1.6 mils	6-90 Series 1.6 - 1.7 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 6

GYPSUM BOARD - ENAMEL COATING

INTERIOR

MANUFACTURER	PRIME	FINISH
Carboline	Multibond - 120 2.0 - 4.0 mils	3359 2.0 - 4.0 mils
PPG	6-2 Speedhide 1.0 - 1.3 mils	6-90 Series 1.6 - 1.7 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 7

GYPSUM BOARD - EPOXY COATING

INTERIOR

MANUFACTURER	PRIME	FINISH
Carboline	Multibond - 120 2.0 - 4.0 mils	890 4.0 - 6.0 mils
PPG	6-2 Speedhide 1.0 - 1.3 mils	97-1 Series 2.0 - 3.0 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 8

CONCRETE MASONRY UNITS - EPOXY COATING
(CHEMICAL RESISTANT)

EXTERIOR AND INTERIOR

MANUFACTURER	PRIME	SEALER	FINISH
Carboline	Flexhide Masonry Black Filler, 75-100 Sq. Ft. Per Gallon	None	890 5.0 - 6.0 mils
PPG	16-90 Black Filler 12.5 mils	None	97-1 Series 2.0 - 3.0 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX A

SYSTEM 9

CONCRETE MASONRY UNITS

ENAMEL COATING

MANUFACTURER	PRIME	SEALER	FINISH
Carbonline	Flexhide Masonry Black Filler 75-100 Sq. Ft. Per Gallon	Flexhide Elastometric Coating 120 Sq. Ft. Per Gallon	Flexhide Elastometric Coating 120 Sq. Ft. Per Gallon
PPG	16-90 Pitt-Glase 12.5 mils	None	6-90 Series 1.6 - 1.7 mils



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SPECIFICATION FOR
ARCHITECTURAL PAINTING

APPENDIX B

MAXIMUM RELATIVE HUMIDITY CHART

Ambient Temperature (Dry Bulb) °F	Maximum Relative Humidity to Maximum 5° Above Dew Point
100	83%
95	82%
90	82%
85	81%
80	80%
75	79%
70	78%
65	75%
60	72%
55	70%
50	68%
45	65%

END OF SECTION

DIVISION 10



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OTIS ANGB, MA
JEG JOB NO.: 35-K784-00


NO. 10500

SPECIFICATION FOR
METAL LOCKERS

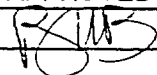
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00					NO. 10500	PAGE 1 OF 3
					SPECIFICATION FOR METAL LOCKERS	
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1.0 GENERAL

1.1 Description

A. This section describes the requirements for finishing and installing metal lockers and locker benches as shown on the drawings.

1.2 Reference Standards (Latest Edition)

A. FS AA-L-00486: Federal Specification for Lockers, Clothing, Steel

1.3 Submittals

A. Shop Drawings

Submit drawings showing layout, dimensions, installation details and product data.

B. Samples

Submit metal color samples for color selection.

1.4 Delivery, Storage and Handling

A. Store lockers in factory packaging until the time of installation.

B. Protect materials before, during and after installation and during the work of other trades.

2.0 PRODUCTS

2.1 Acceptable Manufacturers

A. Republic Storage Systems

B. Medart Inc.

C. Penco Products Inc.



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SPECIFICATION FOR METAL LOCKERS			
2.0 <u>PRODUCTS</u> (continued)			
2.2 <u>Materials</u>			
A. Conform to FS AA-L-00486. Single-tier, and double-tier as indicated on drawings.			
B. Double-tier with coat hooks, number plates, padlock attachment, 2-point latching device, closed base, and sloped hoods, with ventilating louvers in door, size 12" x 15" deep x 36" high.			
C. Locker shall be fabricated from mild-cold rolled steel sheets of the following minimum thickness.			
1. Body and shelf: 22 gage			
2. Doors: 16 gage			
3. Door frames: 16 gage			
4. Base, top and trim: 22 gage			
D. <u>Benches</u>			
1-1/4" thick x 9-1/2" wide x 1'-4" high x length shown on drawings. Hardwood seat with 1-1/4" O.D. steel tube and 10 gage steel flange pedestals spaced at 5'-0" maximum.			
E. <u>Locker Finish</u>			
Baked enamel after phosphatizing and priming.			



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**SPECIFICATION FOR
METAL LOCKERS**

2.0 **PRODUCTS** (continued)

 F. Sealant

 Tremco Acrylic Latex, or as approved. Color to be selected by architect.

 G. Filler Panels

 Provide matching filler panels, trim pieces and other accessories as required to completely finish the installation.

3.0 **EXECUTION**

 3.1 Installation

 A. Assemble and erect lockers in accordance with the manufacturer's instructions, complete with filler panels and sloped metal tops.

 B. Securely fasten with suitable anchoring devices.

 C. Bolt adjoining locker units together to provide a rigid installation.

 D. Install bench pedestal floor flanges on sealant. Clean off all excess sealant.



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NO. 10800

SPECIFICATION FOR
TOILET AND BATH
ACCESSORIES

BY
MH

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SPECIFICATION FOR
TOILET AND BATH ACCESSORIES

1.0 GENERAL

1.1 Description

- A. This section describes the requirements for furnishing and installing toilet and bath accessories as shown on the drawings.

1.2 Related Sections

- A. Section (09250) Gypsum Board System
B. Section (09310) Ceramic Tile

1.3 Quality Assurance

- A. Acceptable manufacturers:
1. Bobrick Washroom Equipment, Inc.
 2. Charles Parker Company
 3. Watrous, Inc.
 4. Ketcham Bathroom Products, Spartan International Corporation

1.4 Submittals

- A. Product data for each accessory item specified.
B. Schedule of Accessories by Room Location.
C. Submit copies of manufacturers installation instructions for each item.

1.5 Product Delivery, Storage, and Handling

- A. Protect stainless steel finish with a removable plastic coating.



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SPECIFICATION FOR
TOILET AND BATH ACCESSORIES

2.0 PRODUCTS

2.1 Devices

A. The following Bobrick model numbers have been used to indicate the type and quality of devices required. Refer to toilet accessory schedule on drawings.

1. Waste Receptacle: Stainless steel with satin finish, B-3644.
2. Mirrors: B-290 (size as shown on the drawings). Mirror frames shall be satin finish stainless steel with corners heliarc welded and ground smooth.
3. Shower Curtain Rod: B-6107
4. Janitor's Utility Unit: B-239, 34" long
5. Personal Product Dispenser: B-3502
6. Towel Bar: B-205, stainless steel (30 inch long)
7. Soap Dish: B-4380
8. Robe Hook: B-671
9. Toilet Paper Dispenser: B-2840
10. Shower Curtain Hooks: 204-1
11. Shower Curtains: 204-2
12. Personal Product Disposal: B-254
13. Surface Mounted Towel Dispenser: B-262
14. Recessed Paper Towel Dispenser: B-359
15. Combination Tower Dispenser/Disposal: B-3944
16. Soap Dispenser: B-8221



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SPECIFICATION FOR TOILET AND BATH ACCESSORIES			
2.0 <u>PRODUCTS (continued)</u>			
B. Provide identifying room plates of two-inch high acrylic plastic, minimum thickness 1/8 inch, in letter style and color selected from the manufacturer's full range by the owner's project representative. Provide one of the following, "RESTROOM" as indicated on the drawings.			
3.0 <u>EXECUTION</u>			
3.1 <u>Preparation and Inspection</u>			
A. Walls to receive accessory units shall be properly reinforced and backing shall be provided where deemed necessary.			
B. Check wall surface and wall openings for correct dimensions, plumbness of blocking or frames and other preparations that would affect installation of accessories.			
C. Verify spacing of plumbing fixtures and toilet partitions that affect installation of toilet accessories.			
3.2 <u>Installation</u>			
A. Provide toilet room accessories level and plumb and of types specified in the locations indicated.			
B. Mount accessories in such a manner as to be tamper proof and secure as recommended by the manufacturer and as approved by the owner's project representative.			
C. Conceal evidence of drilling, cutting and filling.			
3.3 <u>Cleaning</u>			
A. Remove protective plastic coating, temporary labels and all remaining adhesive materials with solvents. Clean by rubbing with damp clean cloth. Polish with soft clean cloth.			

DIVISION 11



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NO. 11313


SPECIFICATION FOR
CENTRIFUGAL PUMPS

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 11313	PAGE 1 OF 9
					SPECIFICATION FOR CENTRIFUGAL PUMPS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
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1.0 GENERAL

1.1 DESCRIPTION

This specification covers the requirements for single stage centrifugal pumps for general water service in continuous operation.

1.2 RELATED SECTIONS

Section 16405, "Specification for Induction Motors"

1.3 REFERENCE STANDARDS

The publications listed below form a part of this specification to the extent referenced. Specifications listed refer to the latest edition. The publications are referred to in the text by the basic designation only.

1.3.1 American National Standard Institute (ANSI)

ANSI/NFPA 70	National Electric Code.
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings.
ANSI B16.5	Steel Pipe Flanges and Flanged Fittings.

1.3.2 American Society for Testing and Materials (ASTM)

ASTM A48	Specification for Gray Iron Castings.
ASTM B 62	Composition Bronze or Ounce Metal Castings.

1.3.3 American Society of Mechanical Engineers (ASME)

ASME B73.1	Horizontal End Suction Centrifugal Pump.
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1.3.4 Hydraulic Institute

Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps.



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SPECIFICATION FOR CENTRIFUGAL PUMPS

1.0 GENERAL (continued)

1.3.5 Occupational Safety and Health Act (OSHA)

1.4 QUALITY ASSURANCE

1.4.1 The following tests shall be performed on each pump of a kind. When specified on the data sheet, the tests shall be witnessed:

- A. Non-Witnessed Performance Test
- B. Non-Witnessed Hydrostatic Test
- C. Non-Witnessed NPSH Test (When $NPSHA - NPSHR \leq 2'$)

Tests shall be performed in accordance with Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc. Tests shall be performed on the actual assembled unit from shut-off head condition to 25 percent above the required design capacity. Prototype model tests will not be acceptable. A record of the tests shall be submitted to the purchaser, prior to shipment, for review and approval.

1.4.2 Acceptance

In the event of failure of any pump of the above requirements or efficiencies, the Vendor shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional compensation, until found satisfactory.

1.4.3 Guarantees and Warranties

Upon completion of manufacturing and testing, the Vendor shall furnish to the purchaser the Manufacturer's written guarantees, that the pumping equipment will operate with the published efficiencies, heads, and flow ranges and meet these specifications. The Vendor shall also furnish the Manufacturer's warranties as published in its literature and as specified.

1.5 SUBMITTALS

The manufacturer shall submit the following:



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SPECIFICATION FOR CENTRIFUGAL PUMPS

1.0 GENERAL (continued)

1.5.1 Drawings

Approval drawings and data shall be submitted as indicated on the Vendor Drawing and Data Request (VDDR) form.

Each drawing shall show the pump name, tag number, purchase order number and client name. Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cut sheets, and installation instructions shall be submitted for information.

1.5.2 Instructions

Instructions for field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the pumps.

1.5.3 Operation and Maintenance Manuals

The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.

2.0 PRODUCTS

2.1 GENERAL

All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.



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SPECIFICATION FOR CENTRIFUGAL PUMPS

2.0 PRODUCTS (continued)

Each unit of pumping equipment shall incorporate all basic mechanisms, coupling, electric motor and unit mounting. All necessary mountings and appurtenances shall be included. Where 2 or more units of the same type and/or size of pumping equipment are required, such units shall all be produced by the same Manufacturer.

2.2 PUMP CONSTRUCTION

Pump materials of construction shall conform to the following requirements unless otherwise specified or indicated.

A. Casing	Ductile iron
B. Pump base	Cast iron or steel
C. Impeller	Stainless steel
D. Shaft	Stainless steel
E. Shaft sleeve	Stainless steel
F. Seal	Mechanical
G. Coupling	Flexible shaft coupling
H. Frame	Frame mounted
I. Bearings	Ball Bearings
J. Lubrication	Oil

2.3 DESIGN

2.3.1 General

A. Pumps shall have stable head/capacity curves that continuously rise to shut off.

B. All equipment should permit rapid and economical maintenance. Major parts, such as casing components and bearing housings, shall be designed to ensure accurate alignment on reassembly either by fully-machined fits or dowels.



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SPECIFICATION FOR CENTRIFUGAL PUMPS

2.0 PRODUCTS (continued)

C. The thickness of the pressure casings shall be suitable for (1) the maximum discharge pressure plus allowances for head and speed increases and (2) hydrostatic test pressure at ambient temperature.

D. The nameplate driver horsepower shall be not less than the horsepower required at any point on the pump curve for the impeller diameter provided, excluding driver service factor.

2.3.2 Casing Connections

A. Pump nozzles shall be flanged type. Flanges shall conform to ANSI B16.1 or ANSI B16.5.

B. Pumps shall have suction flanges designed for the same pressure as the discharge flanges.

C. Pumps shall be furnished with drilled and tapped vent and drain connections.

D. Casing vent and drain connections shall be plugged with solid hexagonal head plugs. Carbon steel plugs shall be used with cast iron casings. When other than case iron casings are used, the plugs shall be of the same material as the casing, unless otherwise specified. Plugs shall have a shank at least 1-1/2 inches in length.

2.3.3 Impellers

A. Pumps with constant speed drivers shall be capable of at least a 5% head increase at rated conditions by replacement of the impeller with one of larger diameter.

B. Pumps that have a suction specific speed (Nss) greater than 11,000 are not acceptable without prior approval.

C. Hydraulically balanced seals shall be furnished for sealing pressure above 75 psig.

D. All metallic parts of the seal shall be 316 stainless steel except the seal plate and throttle bushing.



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SPECIFICATION FOR CENTRIFUGAL PUMPS

2.0 PRODUCTS (continued)

2.3.4 Shafts and Shaft Sleeves

Shaft sleeves shall be supplied for all pumps that have either packing or mechanical seals. Shaft sleeves shall extend beyond the pump gland.

2.3.5 Mechanical Seals

- A. Mechanical seals shall be provided where called out, and they shall be water-flushed, unless otherwise specified.
- B. A throttle bushing shall be provided in order to minimize leakage upon complete failure of the seal.

2.3.6 Bearings and Bearing Housings

- A. Antifriction bearings supplied in the pump (not driver) shall be selected to give a minimum AFBMA L-10 life of 25,000 hours in continuous operation at rated pump conditions but not less than 16,000 hours at maximum loads.
- B. Oil lubricated bearing shall be equipped with constant level oilers. The recommended oil level shall be clearly marked on the outside of the bearing housing.

2.3.7 Materials

- A. Cast iron and ductile iron shall not be repaired by welding unless specifically approved in writing.
- B. Castings shall not be "filled" or "charged" with plastic, sodium silicate, or similar material in order to mask porosity or casting defects.

2.3.8 Couplings and Guards

- A. Couplings shall be constructed in metallic materials only and shall have a minimum service factor of 1.5.



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SPECIFICATION FOR CENTRIFUGAL PUMPS

2.0 PRODUCTS (continued)

- B. Pumps shall be provided with guards for coupling and other exposed rotating components. Guards shall meet OSHA requirements.
- C. Couplings shall be provided with a spacer. The spacer shall provide adequate shaft end clearance for removal of seals and sleeves. It also shall allow for disassembly of back-pull-out type pumps without moving the driver or disconnecting pump nozzles.

2.3.9 Baseplates

- A. Pumps shall be supplied with fabricated steel baseplates. The baseplate shall extend under the pump and driver.
- B. All mounting pads shall be fully machined flat and parallel to receive the equipment. After matching, corresponding surfaces shall be in the same plane within 0.002 inches per foot of the distance between pads. All driver train pads shall be machined to allow for installation of shims that are at least 1/8-inch thick under the driver. All shims shall straddle hold-down bolts and shall be of stainless steel.
- C. A minimum 2-inch vertical clearance shall be provided under the center of each horizontally mounted driver over 60 pounds for insertion of a hydraulic jack.
- D. For horizontal drivers over 60 pounds, horizontal alignment positioning screws shall be provided for each drive element to facilitate longitudinal and transverse horizontal adjustments. The lugs holding the positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the drive element(s).
- E. Baseplates shall be of sufficient strength to allow a four point lift of the assembled unit. Sleeved access holes shall be provided as required for proper grouting to the exterior and interior members of the skid. The sleeves shall be raised to prevent leaks from accumulating over the exposed grout.



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SPECIFICATION FOR CENTRIFUGAL PUMPS

2.0 PRODUCTS (continued)

2.3.10 Paint

Manufacturer's standard paint and color shall be used on the pump and motor, however, the baseplate shall be painted with one coat of polyamide epoxy primer and two coats of high build polyamide epoxy finish coat. The paint manufacturer's recommendations and requirements for surface preparation, dry film thickness, etc. shall be followed by the pump vendor. The selected paint supplier name and system description shall be submitted to purchaser, prior to application, for review and approval.

2.4 EQUIPMENT NAMEPLATE

The 316 stainless steel nameplate and rotational arrow shall be fastened on the pump casing. The following data as a minimum shall be clearly stamped on the name plate. (Minimum 1/8" stencil).

- A. Manufacturer's name and address
- B. Pump size and model number
- C. Manufacturer's serial number
- D. Material of casing and shaft
- E. Rated GPM, TDH, and RPM
- F. Purchaser's item number
- G. Purchaser order number

2.5 PUMP MOTOR

2.5.1 Pump electric motors shall meet the requirements of Section 16405, "Specification for Induction Motors".

2.5.2 Motor drivers shall have horsepower at least equal to the percentage of pump design point brake horsepower as given below:



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SPECIFICATION FOR CENTRIFUGAL PUMPS			
2.0 PRODUCTS (continued)			
<u>Percent of Brake Horsepower</u>			
<u>Motor Ratings</u>	<u>Motors with 1.0 S.F.</u>	<u>Motor with 1.15 S.F.</u>	
25 HP and less	125	115	
30 HP to 75 HP	115	105	
100 HP and over	110	100	
2.5.3 Motors shall be sized for the entire H-Q curve with rated impeller, exclusive of the specified service factor.			
2.6 PREPARATION FOR SHIPMENT			
<p>Water, oil or other liquids used for hydrostatic testing and cleaning shall be drained from all units after testing. All units shall be dried before packing. Internal and external surfaces are to be free from loose scale and other foreign material. All exposed, machined contact surfaces shall be coated with a removable rust preventative and protected against mechanical damage by suitable covers. Plastic tape is not permissible. All openings shall be covered securely with wooden or plastic blind flanges or plugs of suitable design, and the unit shall be made airtight. All units shall be carefully crated and braced to prevent damage during shipment.</p>			



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			SPECIFICATION FOR SUBMERSIBLE WELL PUMPS		
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SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS

1.0 GENERAL

1.1 GENERAL REQUIREMENTS

This specification establishes the minimum requirements for the design, materials, fabrication, testing, inspection, and shipment of vertical submersible turbine type pumps.

1.2 STANDARD PRODUCTS

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Owner's Representative, reasonably convenient to the site. Pumps of the same type shall be the product of one manufacturer.

1.3 REFERENCES

In addition to the requirements of this specification, all pumps shall conform to the latest editions of the following codes and standards as applicable:

1.3.1 American Water Works Association (AWWA)

1.3.2 American Society for Testing and Materials (ASTM)

1.4 NAMEPLATES

Each major item of equipment shall have the manufacturer's name, address, type or style, model, serial number, and catalog number on a stainless steel plate secured to the item of equipment. In addition, the nameplate for each pump shall show the capacity in gallons per minute, rated head in feet, speed in revolutions per minute, equipment tag number and purchase order number. Motor nameplates shall show the horsepower, speed in revolutions per minute, full load current, voltage, frequency, phase, maximum ambient temperature, insulation class code letter, and service factor.

1.5 SUBMITTALS

The pump vendor shall submit the following:



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**SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS**

1.0 GENERAL (continued)

1.5.1 Data

Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cut sheets, and installation instructions shall be submitted for information.

1.5.2 Drawings

Vertical turbine pump system detail drawings consisting of a complete list of equipment and materials shall be submitted for approval. Detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit, shall also be submitted for approval.

Additional data/drawings shall be supplied in accordance with the Vendor Drawing and Data Request (VDDR) form.

1.5.3 Test Reports

Test reports in booklet form showing all tests performed to prove compliance with the specified performance criteria, shall be submitted for information.

1.5.4 Operation and Maintenance Manuals

Manufacturer shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name and model number, a service manual, parts list, and brief description of all equipment and their basic operating features. A copy of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guide shall also be included.

1.6 UTILITIES

Electric power available is 480 volt, 3 phase, 60 hertz.



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SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS

2.0 PRODUCTS

2.1 PUMP AND DRIVER REQUIREMENTS

2.1.1 Pump Drivers

Pumps shall have electric motor drivers.

2.1.2 Well Data

Pumps shall be suitable for installation in the casing size specified in the "Extraction Well Pump Data Summary". Manufacturer shall confirm the minimum required pumpage velocity to adequately cool the motor and shall comment on the casing size needed to produce this annular velocity for the pump size quoted. Additionally, manufacturer shall state the required minimum/maximum discharge pipe velocity and basis for the limit.

2.1.3 Pump Performance

Manufacturer shall supply pumps capable of meeting the performance requirements shown in the "Extraction Well Pump Data Summary".

2.2 SUBMERSIBLE VERTICAL TURBINE PUMPS

Unless otherwise specified, submersible vertical turbine pumps shall be constructed in accordance with AWWA E101. Pumps shall be designed for connection to surface piping. A strainer shall be provided at the pump suction.

2.2.1 Pump Head Assembly

Pump surface head assembly shall be supplied by others.

2.2.2 Pump Bowl Assembly

Pump bowl assembly shall include the pump bowls, impellers, shaft, and bearings and may be of single stage or multistage configuration.



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SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS

2.0 PRODUCTS (continued)

2.2.3 Pump Bowls

Pump bowls shall have integrally-cast vanes with smooth, streamlined water passageways, and shall be constructed of close-grained cast-iron, and shall be lined with porcelain enamel. Pump bowls shall be equipped with replaceable seal rings on the suction side for pumps with enclosed impellers.

2.2.4 Impellers

Impellers shall be of bronze and shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the nameplate rating, exclusive of any service factor, over the entire performance range of the pump.

2.2.5 Pump Shafts

Pump shafts shall be stainless steel and the pump-motor coupling shall be stainless steel capable of transmitting the required thrust in either direction.

2.2.6 Bearings

Intermediate bowl bearings shall be water-lubricated bronze or fluted rubber. Top bowl bearings and suction interconnecting bearings shall be grease packed bronze or water-lubricated bronze or fluted rubber. Grease in grease-packed bearings shall be nonwater-soluble hydraulic type permanently sealed against loss. Grease-packed bearings shall be provided with sand caps to prevent intrusion of abrasive particles. Thrust bearings shall be located in the pump motor.

2.2.7 Strainer

A stainless steel strainer (screen) shall be furnished at the pump suction. The strainer shall have a net area of at least four times the eye area of the impeller.

2.2.8 Check Valve

A check valve shall be furnished for each pump assembly. The check valve may be either a separate or a built-in type. Pump vendor shall recommend necessity for providing a drilled hole in the check valve flapper as a means of avoiding pulling a "wet string" and shall comment on possible adverse affects to the pump.



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**SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS**

2.0 PRODUCTS (continued)

2.2.9 Discharge Pipe

Discharge column pipe and pipe centralizers (spiders used to center pipe in well casing) shall be provided by others.

2.3 ELECTRIC MOTOR DRIVER REQUIREMENTS

2.3.1 Electric Motors

Submersible motors shall be designed and manufactured expressly for the intended use. Motors shall be rated 480 volts, 3 phase, 60 Hz and such rating shall be stamped on the nameplate. Submersible motors may be the wet-stator type, dry-stator type, or oil-filled stator type. Wet-stator motors shall be filled at the factory with water treated to minimize corrosion, and shall be provided with a seal to keep interchange of cooling water and water being pumped to a minimum. Windings shall be insulated with a waterproof material. Dry-stator motors shall have rotor bearings immersed in a coolant lubricant of water-oil or water-glycol mixture, or a water-grease emulsion. When the coolant is water, it may be sealed in the motor or allowed to flow through the motor, depending upon design. Stator case shall be hermetically sealed and may be filled with a solid plastic material to help dissipate heat. Oil-filled stator motors shall be completely filled with high-dielectric constant oil. A mechanical seal shall be provided between the shaft and the motor housing and shall be designed to minimize the loss of oil. An oil reservoir shall be provided to replenish the oil loss for the life of the motor. Wet-stator motors and oil-filled stator motors shall employ a system to automatically balance the liquid pressure in the motor at any depth of submergence up to the maximum allowable. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearings shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust, and shall be capable of withstanding the upthrust imposed during pump starting.

2.3.2 Power Cables

Submersible power cables shall be specifically designed for use with submersible pumps, and shall be as recommended by the manufacturer of the motors with which the cables are used.



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SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS

2.0 PRODUCTS (continued)

Each cable shall be not less than No. 12 AWG stranded copper and shall have an ampacity of not less than 125 percent of the motor full load current. Each conductor shall be insulated with a heat resistant, moisture resistant synthetic rubber or thermosetting plastic jacket. A separate stranded, green insulated, grounding conductor shall be provided for each circuit. Single- and multiple-conductor cables shall be jacketed with a watertight synthetic rubber, plastic, or metal jacket impervious to oil or water and highly resistant to oils, acids and most chemicals. Metal jackets shall have a polychloroprene covering. Submersible cables shall be suitable for continuous immersion in water at the maximum depth encountered. Multiple-conductor cables may be used for ampacities up to and including 200 amperes; for greater ampacities single-conductor cables or two multiple-conductor cables shall be used.

Splices in cables will be allowed only at the connection to the motor, and may be made at that point only if there is sufficient room in the well casing without interfering with proper pump setting and operation. A waterproof plug and connector or other type of fitting may be provided for connection of the cable at the motor. Such connection shall be suitable for continuous immersion at the maximum water depth encountered.

Where cables pass the pump bowl assembly, cables shall be flat or protected against damage by a corrosion-resistant shield forming a smooth rounded surface. Sharp bends in the cables at the shield or at the connection to the motor will not be allowed.

The pump manufacturer shall supply power cable in lengths specified in the "Extraction Well Pump Data Summary".

2.4 PAINTING AND FINISHING

All exposed ferrous metal shall be factory painted. Nameplates shall not be covered with paint but shall be cleaned and legible at completion of the work.



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SPECIFICATION FOR
SUBMERSIBLE WELL PUMPS

3.0 INSPECTION AND TESTING

3.1 Factory Pump Test

The pump manufacturer shall provide performance testing on each different type/size of pump supplied. Testing shall not be required on each pump unless each pump is a unique size. Testing shall be conducted at manufacturer's shop facilities and manufacturer shall provide certificates of these tests. At Owner's discretion, the performance test shall be observed by Owner or Owner's Representative. Factory pump testing shall be made in conformance with AWWA E101 and include the following:

- A. Run test.
- B. Performance Test.
- C. Sample calculation from test readings.
- D. Hydrostatic test of bowl assembly and discharge head.

All testing shall be recorded in writing.



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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BY JEC		APPROVED RMS	ISSUE DATE 8/15/96	SPECIFICATION FOR VERTICAL SUMP PUMPS	
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1.0 GENERAL

1.1 GENERAL REQUIREMENTS

This specification establishes the minimum requirements governing the design, materials, fabrication, testing, inspection and preparation for shipment of vertical sump pumps for medium duty intermittent service.

1.2 RELATED SECTIONS

Section 16405 "Specification for Induction Motors"

1.3 REFERENCE STANDARDS

The publications listed below form a part of this specification to the extent referenced. Specifications listed refer to the latest edition. The publications are referred to in the text by the basic designation only.

1.3.1 Occupational Safety and Health Administration (OSHA) Safety

1.3.2 American Gear Manufacturers Association (AGMA) Gear Design

1.3.3 American National Standards Institute (ANSI) Flanges B16.5 and Pipe Threads B2.1

1.3.4 Hydraulics Institute Standards (HIS) Design and Testing

1.4 QUALITY ASSURANCE

1.4.1 Testing requirements are specified on pump data sheets.

1.4.2 On tested pumps, all records of tests performed, including tests required for compliance with regulatory or industry codes, shall be submitted to the purchaser, prior to shipment, for review and approval.

1.4.3 In the event of failure of any pump, the vendor shall make all necessary modifications, repairs or replacements to conform to the requirements of the Contract documents and the pump shall be re-tested at no additional compensation.



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SPECIFICATION FOR VERTICAL SUMP PUMPS			
<p>1.0 GENERAL (continued)</p> <p>1.4.4 Guarantees and Warranties</p> <p>Upon completion of manufacturing and testing, the Vendor shall furnish to the purchaser the Manufacturer's written guarantees, that the pumping equipment will operate with the published efficiencies, heads, and flow ranges and meet these specifications. The Vendor shall also furnish the Manufacturer's warranties as published in its literature and as specified.</p> <p>1.5 SUBMITTALS</p> <p>The manufacturer shall submit the following:</p> <p>1.5.1 Drawings</p> <p>Approval drawings and data shall be submitted as indicated on the Vendor Drawing and Data Request (VDDR) form:</p> <p>Each drawing shall show the pump name, tag number, purchase order number and client name. Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cut sheets, and installation instructions shall be submitted for information.</p> <p>1.5.2 Instructions</p> <p>Instructions for field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the pumps.</p> <p>1.5.3 Operation and Maintenance Manuals</p> <p>The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basis operations features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.</p>			



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**SPECIFICATION FOR
VERTICAL SUMP PUMPS**

2.0 PRODUCTS

2.1 GENERAL

All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.

Each unit of pumping equipment shall incorporate all basic mechanisms, coupling, electric motor and unit mounting. All necessary mountings and appurtenances shall be included. Where 2 or more units of the same type and/or size of pumping equipment are required, such units shall all be produced by the same Manufacturer.

2.2 DESIGN

2.2.1 It is the intent of this specification that the equipment be the manufacturer's standard design, modified as required, and suitable for application and capacities specified.

2.2.2 Vendor may present alternatives, with justification, that provide improved design, better delivery, reduced cost, or increased operating efficiency. Such alternative shall be completely defined in the vendors proposal.

2.2.3 Power shall be transmitted from motor to pump by means of a flexible coupling.

2.2.4 Lineshaft steady bearings (if required) shall be designed for dry running. (External clean water flush is not available and product flush is not recommended.)

2.2.5 Coupling guard shall meet OSHA requirements.

2.2.6 Rated impeller diameter shall be 95% or less of maximum impeller diameter.

2.2.7 Normal operating point of maximum impeller shall be to the left of the Best Efficiency Point (BEP) on the pump performance curve. Rated capacity shall be no more than 5% greater in flow than "BEP" flow of rated impeller.

2.2.8 A lip seal shall be provided as a minimum for shaft sealing. Applications requiring mechanical seals, packing, or vapor proof construction will be noted on the pump data sheets.



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**SPECIFICATION FOR
VERTICAL SUMP PUMPS**

2.0 PRODUCTS (continued)

2.2.9 Standard manufacturers mounting plate shall be provided. Level control accessories will be provided by others.

2.2.10 Discharge pipe shall be raised face flange on metallic pumps and flat face flange on non-metallic pumps (FRP).

2.2.11 Double run angular contact thrust bearings shall be provided in the pump (not driver) and shall be grease lubricated.

2.2.12 The pump shall be supplied with a stainless steel suction strainer.

2.2.13 Line shaft steady bearings shall be located in the head column every 3 feet for 3600 rpm applications and every 5 feet for 1800 rpm applications.

2.2.14 Manufacturer's standard paint and color shall be used on the pump and motor.

2.3 PUMP MOTOR

2.3.1 Pump electric motor shall meet the requirements of Section 16405, "Specification for Induction Motors".

2.3.2 Motor drivers shall have horsepower at least equal to the percentage of pump design point brake horsepower as given below:

<u>Motor Ratings</u>	<u>Percent of Brake Horsepower</u>	
	<u>Motors with 1.0 S.F.</u>	<u>Motor with 1.15 S.F.</u>
25 HP and less	125	115
30 HP to 75 HP	115	105
100 HP and over	110	100

2.3.3 Motors shall be sized for the entire H-Q curve with rated impeller, exclusive of the specified service factor.

2.4 Equipment Nameplate

The stainless steel nameplate and rotational arrow shall be fastened on the pump motor support. The following data as a minimum shall be clearly stamped on the name plate. (Minimum 1/8" stencil).



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SPECIFICATION FOR
VERTICAL SUMP PUMPS

2.0 PRODUCTS (continued)

- A. Manufacturer's name and address
- B. Pump size and model number
- C. Manufacturer's serial number
- D. Impeller diameter and material
- E. Material of casing and shaft
- F. Rated GPM, TDH, and RPM
- G. Purchaser's item number
- H. Purchase order number

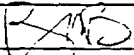

2.5 Preparation For Shipment

Water, oil or other liquids used for hydrostatic testing and cleaning shall be drained from all units. All units shall be dried before packing. Internal and external surfaces are to be free from loose scale and other foreign material. All exposed, machined contact surfaces shall be coated with a removable rust preventative and protected against mechanical damage by suitable covers. Plastic tape is not permissible. All openings shall be covered securely with blind flanges or plugs of suitable design, and the unit shall be made airtight. All units shall be carefully crated and braced to prevent damage during shipment. Each unit is to be identified with a stainless steel shipping tag securely attached and plainly marked with purchaser's item number and purchase order number. All loose parts shall be packaged and identified in the same manner.



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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 11316		
			SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS		
BY JEC	APPROVED 	ISSUE DATE 8/15/96			
<p>THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.</p> <p>FOR CONVENIENCE, THE NATURE OF THE REVISION IS BRIEFLY NOTED UNDER REMARKS. THESE REMARKS ARE NOT A PART OF THE DOCUMENT. THE REVISED PAGES ARE A PART OF THE DOCUMENT AND SHALL BE COMPLIED WITH IN THEIR ENTIRETY</p>					
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 11316	PAGE 1 OF 6
BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS	
JEC	<i>[Signature]</i>		0	8/15/96		
1.0 GENERAL						
1.1 GENERAL REQUIREMENTS						
This specification establishes the minimum requirements for progressive cavity pumps for continuous operation in sludge service.						
1.2 RELATED SECTIONS						
Section 16405, "Specification for Induction Motors"						
1.3 REFERENCE STANDARDS						
The publications listed below form a part of this specification to the extent referenced. Specifications listed refer to the latest edition. The publications are referred to in the text by the basis designation only.						
1.3.1 Occupational Safety and Health Administration (OSHA) - Safety						
1.3.2 American Gear Manufacturers Association (AGMA) - Gear Design						
1.3.3 American National Standards Institute (ANSI) - Flanges B16.5 and Pipe Threads B2.1						
1.3.4 American Petroleum Institute (API) - Seal Piping						
1.4 QUALITY ASSURANCE						
1.4.1 Testing requirements are specified on pump data sheets.						
1.4.2 On tested pumps, all records of tests performed, including tests required for compliance with regulatory or industry codes, shall be submitted to the purchaser, prior to shipment, for review and approval.						
1.4.3 In the event of failure of any pump, the vendor shall make all necessary modifications, repairs or replacements to conform to the requirements of the Contract documents and the pump shall be re-tested at no additional compensation.						



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SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS

1.0 GENERAL (continued)

1.4.4 Guarantees and Warranties

Upon completion of manufacturing and testing, the Vendor shall furnish to the Purchaser the Manufacturer's written guarantees, that the pumping equipment will operate with the published efficiencies, heads, and flow ranges and meet these specifications. The Vendor shall also furnish the Manufacturer's warranties as published in its literature and as specified.

1.5 SUBMITTALS

The manufacturer shall submit the following:

1.5.1 Drawings

Approval drawings and data shall be submitted as indicated on the Vendor Drawing and Data Request (VDDR) form.

Each drawing shall show the pump name, tag number, purchase order number and client name. Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cut sheets, and installation instructions shall be submitted for information.

1.5.2 Instructions

Instructions for field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the pumps.

1.5.3 Operation and Maintenance Manuals

The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basis operations features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.



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SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS

2.0 PRODUCTS

2.1 GENERAL

All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.

Each unit of pumping equipment shall incorporate all basic mechanisms, coupling, electric motor and unit mounting. All necessary mountings and appurtenances shall be included. Where 2 or more units of the same type and/or size of pumping equipment are required, such units shall all be produced by the same Manufacturer.

2.2 DESIGN

2.2.1 It is the intent of this specification that the equipment be the manufacturer's standard design, modified as required, and suitable for application and capacities specified.

2.2.2 Vendor may present alternatives, with justification, that provide improved design, better delivery, reduced cost, or increased operating efficiency. Such alternatives shall be completely defined in the vendor's proposal.

2.2.3 Pump construction, specific design requirements and materials of construction are listed on the individual data sheets.

2.2.4 Unless specifically called for on the pump data sheets, the pumps shall be directly coupled to gear boxes or gearhead motors. Belt drives shall not be used.

2.2.5 Pumps shall be designed for the specified capacity and pressure when handling fluids of the minimum viscosity given on pump data sheets. The brake horsepower required shall be based on the maximum viscosity given on the pump data sheets.

2.2.6 Inlet and outlet connections shall be flanged and suitable for the maximum working pressure of the pump. If flanged connections are impractical, threaded connections may be approved by purchaser. Threaded connections shall be a minimum of Schedule 160 seamless for 1" and smaller and Schedule. 80 for larger than 1.5".



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SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS			
2.0 PRODUCTS (continued)			
2.2.7 Radial bearings shall be of the anti-friction type, except internal bearings, which may be of sleeve or needle design.			
2.2.8 Anti-friction bearings shall be warranted for a minimum of 25,000 hours B-10 bearing life.			
2.2.9 External anti-friction bearings may be grease or oil lubricated.			
A. Grease lubricated bearings shall have drain plugs and hydraulic fittings for regreasing.			
B. Oil lubricated bearings shall have drain plugs and constant level oilers with protected transparent containers.			
C. Bearings subjected to temperatures above 250°F shall be water cooled.			
2.2.10 Internal bearings of the sleeve or needle type shall be warranted for a minimum of 9,000 hours B-10 bearing life.			
2.2.11 Couplings shall be of the flexible type and have a minimum service factor of 1.5.			
2.2.12 Gear drive bearings shall be of the anti-friction type, oil lubricated and warranted for a minimum of 25,000 hours B-10.			
2.2.13 Gear drive unit shall have oil level sight glasses or constant level oilers with protected containers.			
2.2.14 Safety guards and shields shall be furnished for all exposed rotating parts. In addition to the local state regulations and requirements, all guards shall conform to the requirements of OSHA.			
2.2.15 Jackets for cooling or steam heating shall be supplied on pumps where specified on the individual pump data sheets.			
2.2.16 Pumps shall be supplied with fabricated steel baseplates. All mounting pads shall be fully machined flat and parallel to receive the equipment. Baseplates shall be of sufficient strength to allow a four point lift of the assembled unit.			



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SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS

2.0 PRODUCTS (continued)

2.2.17 Mechanical Seals/Seal Flush Piping

- A. Mechanical seals or packing have been specified by the purchaser and are as indicated on the data sheets. Unless otherwise noted, all mechanical seals shall be supplied and installed by the pump vendor. Pump Vendor is responsible for verifying that selected seals on data sheets are suitable for proposed pump stuffing box. All seal flush arrangements shall be specified by purchaser and supplied by the pump manufacturer.
- B. Cartridge type non-bellows mechanical seals are preferred on alloy and "FRP" material pumps.
- C. Seal piping shall be in accordance with API Standard 610.
- D. Pumps shall be furnished with lantern ring connections in the stuffing box. Lantern ring connections will be used to flush stuffing box with clean water. Tube connections shall be threaded and plugged.
- E. Pumps furnished with seal flush plan 32 shall contain a throat bushing in the stuffing box to restrict external water flush from entering the pumpage.
- F. Gland connections shall be clearly labeled (V = VENT Connection, etc.).

2.2.18 Paint

Manufacturer's standard paint and color shall be used on the pump and motor, however, the baseplate shall be painted with one coat of polyamide epoxy primer and two coats of high build polyamide epoxy finish coat. The paint manufacturer's recommendations and requirements for surface preparation, dry film thickness, etc. shall be followed by the pump vendor. The selected paint supplier name and system description shall be submitted to purchaser, prior to application, for review and approval.

2.3 ELECTRICAL

Pump electric motor shall meet the requirements of Section 16405, "Specification for Induction Motors".



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SPECIFICATION FOR PROGRESSIVE CAVITY PUMPS

2.0 PRODUCTS (continued)

2.4 EQUIPMENT NAMEPLATE

The 316 stainless steel nameplate and rotational arrow shall be fastened on the pump casing. The following data as a minimum shall be clearly stamped on the name plate. (Minimum 1/8" stencil).

- A. Manufacturer's name and address
- B. Pump size and model number
- C. Manufacturer's serial number
- D. Material of casing and shaft
- E. Rated GPM, TDH, and RPM
- F. Purchaser's item number
- G. Purchaser order number

2.5 PREPARATION FOR SHIPMENT

Water, oil or other liquids used for hydrostatic testing and cleaning shall be drained from all units after testing. All units shall be dried before packing. Internal and external surfaces are to be free from loose scale and other foreign material. All exposed, machined contact surfaces shall be coated with a removable rust preventative and protected against mechanical damage by suitable covers. Plastic tape is not permissible. All openings shall be covered securely with wooden or plastic blind flanges or plugs of suitable design, and the unit shall be made airtight. All units shall be carefully crated and braced to prevent damage during shipment.

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JEG JOB NO. 35-K-784-00

NO. 11317

SPECIFICATION FOR
CONTROLLED VOLUME POSITIVE
DISPLACEMENT PUMPS

BY	APPROVED	ISSUE DATE
JEC	RMS	8/15/96

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 11317	PAGE 1 OF 5										
<table border="1"><tr><td>BY</td><td>APPROVED</td><td>ISSUE DATE</td><td>REV. NO.</td><td>DATE</td></tr><tr><td>JEC</td><td><i>[Signature]</i></td><td></td><td>0</td><td>8/15/96</td></tr></table>					BY	APPROVED	ISSUE DATE	REV. NO.	DATE	JEC	<i>[Signature]</i>		0	8/15/96	SPECIFICATION FOR CONTROLLED VOLUME POSITIVE DISPLACEMENT PUMPS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE												
JEC	<i>[Signature]</i>		0	8/15/96												
1.0 GENERAL																
1.1 GENERAL REQUIREMENTS																
This specification establishes the minimum requirements for the inspection, testing and preparation for shipment of controlled volume positive displacement pumps.																
1.2 RELATED SECTIONS																
Section 16405, "Specification for Induction Motors"																
1.3 REFERENCE STANDARDS																
The publications listed below form a part of this specification to the extent referenced. Specifications listed refer to the latest edition. The publications are referred to in the text by the basis designation only.																
1.3.1 Occupational Safety and Health Administration (OSHA) - Safety																
1.3.2 American Gear Manufacturers Association (AGMA) - Gear Design																
1.3.3 American National Standards Institute (ANSI) - Flanges B16.5 & Pipe Threads B2.1																
1.3.4 American Petroleum Institute (API) - Design Standard 675 ("Positive Displacement Pumps, Controlled Volume")																
1.4 QUALITY ASSURANCE																
1.4.1 The following tests shall be performed on each pump of a kind. When specified on the data sheet, the tests shall be witnessed:																
A. Non-Witnessed Performance Test																
B. Non-Witnessed Hydrostatic Test																
Tests shall be performed in accordance with API 675. If specified on the data sheet, testing shall include a repeatability/linearity test at 100, 75, 50, 25 and 10 percent of rated capacity in descending and ascending order. Variations shall not exceed +/- 3% of rated capacity. Prototype model tests will not be acceptable. A record of the tests shall be submitted to the purchaser, prior to shipment, for review and approval.																



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**SPECIFICATION FOR CONTROLLED
VOLUME POSITIVE DISPLACEMENT PUMPS**

1.0 GENERAL (continued)

1.4.2 Acceptance

In the event of failure of any pump of the above requirements, the Vendor shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional compensation, until found satisfactory.

1.4.3 Upon completion of manufacturing and testing, the purchaser shall furnish to the Contractor the Manufacturer's written guarantees, that the pumping equipment will operate with the published efficiencies, heads, and flow ranges and meet these specifications. The Vendor shall also furnish the Manufacturer's warranties as published in its literature and as specified.

1.5 SUBMITTALS

The manufacturer shall submit the following:

1.5.1 Drawings

Approval drawings and data shall be submitted as indicated on the Vendor Drawing and Data Request (VDDR) form.

Each drawing shall show the pump name, tag number, purchase order number and client name. Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cut sheets, and installation instructions shall be submitted for information.

1.5.2 Instructions

Instructions for field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the pumps.



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**SPECIFICATION FOR CONTROLLED
VOLUME POSITIVE DISPLACEMENT PUMPS**

1.0 GENERAL (continued)

1.5.3 Operation and Maintenance Manuals

The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their base operating features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.

2.0 PRODUCTS

2.1 GENERAL

All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.

Each unit of pumping equipment shall incorporate all basic mechanisms, coupling, electric motor and unit mounting. All necessary mountings and appurtenances shall be included. Where 2 or more units of the same type and/or size of pumping equipment are required, such units shall all be produced by the same Manufacturer.

2.2 DESIGN

2.2.1 Pumps and drivers shall be designed for continuous operation at design conditions. Rated capacity shall be at least 110 percent of the maximum capacity specified.

2.2.2 Pumps shall be positive displacement plunger or diaphragm type (unless otherwise noted on data sheet), directly coupled to driving motor, aligned and ready for operation.

2.2.3 Suction and discharge check valve seats and elements shall be field replaceable. Proper guiding of the check valve element shall be provided for quick seating action and maximum seal life. Double check valves (both suction and discharge) shall be furnished when specified on the data sheet.



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**SPECIFICATION FOR CONTROLLED
VOLUME POSITIVE DISPLACEMENT PUMPS**

2.0 PRODUCTS (continued)

- 2.2.4 Stroke adjustment shall be possible over the range of 0 to 100% of design pump rate. Accuracy shall be +/-1% over a turndown ratio of 10:1
- 2.2.5 Inlet and outlet connections shall be flanged and suitable for the maximum working pressure of the pump. If flanged connections are impractical, threaded connections may be approved by purchaser. Threaded connections shall be a minimum of Schedule 160 seamless for 1" and smaller and Schedule. 80 for larger than 1.5".
- 2.2.6 Pulsation suppression devices shall be supplied for both suction and discharge connections. The manufacturer shall recommend the type of device to be used relative to the service conditions specified in the pump data sheets.
- 2.2.7 A relief valve shall be supplied with the pump to provide protection from excessive discharge pressure. The relief valve may be integral to the pump, in the case of diaphragm type pumps, or separate, for plunger pumps. The relief valve setting shall be at least 10 percent over the rated discharge pressure. The relief valve shall be self-seating and shall be easily accessible for adjustment, repair, or replacement.
- 2.2.8 Packed-plunger liquid ends shall provide for proper guiding of the plunger through the complete stroke cycle with minimum side loading against the packing. A lantern ring shall be provided in the stuffing box for flushing or adding lubricant to the packing. The pump body shall have a minimum 1/4 inch NPT drilled and tapped hole on the top and bottom, in line with the lantern ring to provide inlet and outlet for flushing. When a packing lubricant is used, the bottom hole shall have a threaded plug installed.
- 2.2.9 Maximum plunger speed shall not exceed 130 feet per minute; 90 strokes per minute. (70 to 80 strokes per minute is preferred.)
- 2.2.10 Pumps shall be supplied with fabricated steel baseplates when specified on the data sheets.
- 2.2.11 Manufacturer's standard paint and color shall be used on the pump and motor.



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**SPECIFICATION FOR CONTROLLED
VOLUME POSITIVE DISPLACEMENT PUMPS**

2.0 PRODUCTS (continued)

2.3 EQUIPMENT NAMEPLATE

The 316 stainless steel nameplate and rotational arrow shall be fastened on the pump casing. The following data as a minimum shall be clearly stamped on the name plate. (Minimum 1/8" stencil).

- A. Manufacturer's name and address
- B. Pump size and model number
- C. Manufacturer's serial number
- D. Material of casing and shaft
- E. Rated GPM, TDH, and RPM
- F. Purchaser's item number
- G. Purchaser order number

Each pump shall be furnished with a stainless steel nameplate permanently attached to the pump and indicating Manufacturer's name and model number, rated capacity, relief valve set pressure, size and type of pump, equipment tag number and Purchase Order number.

2.4 MOTORS

Pump motors shall meet the requirements of Section 16405, "Specification for Induction Motors."

2.5 PREPARATION FOR SHIPMENT

Water, oil or other liquids used for hydrostatic testing and cleaning shall be drained from all units after testing. All units shall be dried before packing. Internal and external surfaces are to be free from loose scale and other foreign material. All exposed, machined contact surfaces shall be coated with a removable rust preventative and protected against mechanical damage by suitable covers. Plastic tape is not permissible. All openings shall be covered securely with wooden or plastic blind flanges or plugs of suitable design, and the unit shall be made airtight. All units shall be carefully crated and braced to prevent damage during shipment.



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NO. 11340

SPECIFICATION FOR
GREENSAND FILTERS

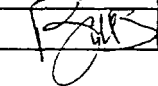
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 11340	PAGE 1 OF 9
					SPECIFICATION FOR GREENSAND FILTERS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
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1.0 GENERAL

1.1 SYSTEM DESCRIPTION

This specification establishes the minimum requirements for the design, fabrication, delivery, and placement into successful operation of a greensand filter system for the removal of manganese and iron from water. The system shall be completely engineered and self contained to the degree shown on the piping and instrument diagrams, and include all interconnecting piping, valves, instrumentation, electrical hardware, vessels, pumps and accessories for continuous operations.

1.2 RELATED SECTIONS

Section 09900 "Shop and Field Coating"

Section 11317 "Specification for Controlled Volume Positive Displacement Pumps"

Section 13431 "Specification for Electrical Motor Valve Operators"

Section 16011 "Electrical Requirements for Package Equipment"

Section 16405 "Specification for Induction Motors"

JEG No. 13-001 "Pressure Vessels Carbon & Low Alloy Steel"

JEG No. 39-001 "General Welding Requirements for Pressure Equipment"

1.3 REFERENCE STANDARDS

The latest edition of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.3.1 American Society For Testing And Materials (ASTM)

ASTM A 48 Gray Iron Castings



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SPECIFICATION FOR GREENSAND FILTERS	
1.0 GENERAL (continued)	
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 530	Seamless and Welded Austenitic Stainless Steel Pipe.
ASTM D 1785	Poly Vinyl Chloride (PVC) Plastic Pipe Schedules 40, 80, and 120
1.3.2 American National Standards Institute (ANSI)	
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Steel Pipe Flanges and Flanges Fittings
ANSI/AWS D1.1	Structural Welding Code
1.3.3 American Society Of Mechanical Engineers (ASME)	
ASME Section VIII Div 1	Boiler and Pressure Vessel Code, Section VIII, Pressure Vessel Division 1 Basic Coverage
1.3.4 American Water Work Association (AWWA)	
1.3.5 National Electric Code (NEC)	
1.3.6 Occupational Safety And Health Act (OSHA)	



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SPECIFICATION FOR GREENSAND FILTERS	
1.0	GENERAL (continued)
1.4	QUALITY ASSURANCE
1.4.1	<p>A jobsite Acceptance Test ("TEST") shall be conducted to confirm that the system, when operated under the design conditions and in accordance with the Operating and Maintenance Manuals, is functioning properly. Influent water quality shall contain organic constituents and inorganic compounds equivalent to those listed in the system data sheets. The Test will commence after completion of satisfactory system checkout and initial start-up operations. The system shall be operated for a four (4) hour period during which it will be tested to verify performance requirements. During the Test, the purchaser, or purchaser's representative shall perform operations and maintenance under vendor's surveillance. A plan to define instrument calibration requirements, chemical addition rates, measurement points, preservation methods, chemical laboratory selection, QA/QC procedures, and other necessary procedures shall be mutually agreed in writing no later than ten (10) working days prior to the Test. The Test Plan shall include provisions for taking split samples as requested by Vendor (any analysis of vendor's split at vendor's expense). The purchaser is responsible for the analytical expenses they incur during the acceptance test. The system shall be deemed to have passed the Test when effluent water is treated to the design water quality requirement with the unit operated at the design flow rates. The Acceptance Test shall be conducted within thirty (30) days of start-up of the system.</p>
1.5	SUBMITTALS
1.5.1	<p>Drawings and Data</p> <p>Approval drawings and data shall be submitted as indicated on the vendor drawing and data request (VDDR) form. Each drawing shall show the system tag number and name, purchase order number and client name. Data requirements include, but are not limited to, the following:</p> <ul style="list-style-type: none">A. Calculations which clearly support the scale-up of the proposed system; including the greensand bed depth and volume requirement, chemical addition requirements, and system pressure drop.B. Structural calculations for the system shells, tanks, and mounting and support details.C. Drawings showing placement of the system relative to external piping, valves, and other equipment that must be interfaced.



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SPECIFICATION FOR GREENSAND FILTERS

1.0 GENERAL (continued)

D. Details on all instrumentation and controls including make and model numbers.

E. Complete list of equipment and materials, including manufacturers descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions.

F. Material safety data sheets (MSDS) for all proposed chemicals.

G. A description of any required procedures for storage, handling, and installation of the systems at the site.

H. A complete list of parts, supplies and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply. A list of the parts recommended by the manufacturer to be replaced after 2 years of service. A priced list of commissioning spares.

I. Test reports in booklet form showing all field tests performed to demonstrate compliance with the specified performance criteria, upon completion and testing of the installed system.

J. Complete electrical schematics and wiring diagrams, including terminal and wire tags, control device tags, physical location of controls in the control panel, etc.

K. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering as appropriate, in the State in which the system was fabricated, stating that: 1) The fabrication drawings, pressure calculations for the shells and seismic design calculations were designed for the listed conditions in accordance with the appropriate codes and standards. 2) The erection drawings for the shells and supports were designed for the listed conditions in accordance with the appropriate codes and standards.

1.5.2 INSTRUCTIONS

Instructions and field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the equipment.



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SPECIFICATION FOR GREENSAND FILTERS

1.0 GENERAL (continued)

1.5.3 Operations And Maintenance Manuals

The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.

2.0 PRODUCTS

2.1 GENERAL

All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.

2.2 DESIGN

2.2.1 Performance

The system shall be designed to function as shown on the piping and instrument diagrams and as detailed in this specification. System performance requirements and influent water quality are shown on the greensand filter data sheets. The general system orientation is depicted on the equipment arrangement drawing.

2.2.2 Materials

Materials of construction are specifically outlined in the equipment data sheets. A general overview of major equipment materials as follows:

- A. Interconnecting piping - 316L stainless steel
- B. Vessels - A516 70 (coated internally with manufacturer's standard corrosion resistant paint system)
- C. Potassium permanganate mix tank - HDPE
- D. Fabricated Steel Structures - A36 (or manufacturer standard)



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SPECIFICATION FOR GREENSAND FILTERS			
2.0 PRODUCTS (continued)			
2.2.3 Equipment			
A. Greensand Filter System			
<p>Free standing vessels with interconnecting piping spools are envisioned. The KMnO4 mix tank and metering pumps would be mounted on a single prewired and prepped skid. This arrangement is not mandatory, however, the objective is to minimize field assembly, piping fabrication and wiring where possible. Regardless of the design approach, the entire system must be contained within the plot limits shown on the equipment arrangement drawing. Where the skid approach is used all instrument devices and electrical equipment shall be prewired and terminated at edge of skid in a NEMA 4X junction box. Skid piping terminations shall be flanged and shall be brought to the edge of skid. The system shall include one spare filter unit to be used as a standby in the backwash mode.</p>			
B. Greensand Filter Vessels			
<p>Vessels shall be designed in accordance with ASME Section VIII Division 1, and shall be code stamped and national board registered. Four structural legs, welded to the bottom head or side shell, shall be provide for support. The legs shall have drilled baseplates such that the vessels can be adequately and safely bolted to a concrete pad. The vessels shall be externally painted in accordance with Section 0900 "Shop and Field Coating", and internally coated with vendor's standard corrosion and abrasion resistant paint system.</p> <p>Each vessel shall be provide with an under-drain system consisting of a 316L header, and 316L laterals and distributors. The under-drain system shall assure uniform collection and distribution and provide operation of both backwashing and filtration.</p> <p>The inlet distributor shall be designed to produce a uniform flow profile across the diameter of the bed in the downflow direction.</p> <p>The filter drain shall provide for enough freeboard to assure that no more than 1" per year of filter media is lost during backwash operations.</p> <p>Each vessel shall be provided with 2 manways located in the vessel shell just above the bottom section tangent line. The manway shall be a quick opening swing bolt design.</p>			



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SPECIFICATION FOR GREENSAND FILTERS

2.0 PRODUCTS (continued)

C. Filter Media

The supporting gravel bed shall be free from foreign materials such as dirt, shale, mica, sand or clay loam and shall be composed of rounded and/or angular particles. The gravel shall conform to physical and chemical properties of AWWA standard for filtering material, B100. Bed depth and layering structure shall be per manufacturer's recommendation.

The filter media shall be placed on top of the support gravel and consist of manganese greensand zeolite, topped with anthracite. The bed depth of each shall be suitable to meet the process performance requirements stated in the greensand filter data sheets. The manganese greensand shall be new material, processed and stabilized to be suitable for use in the continuous regeneration process with potassium permanganate. Both greensand and anthracite media shall be free of shale, mica, clay, dirt and organic impurities and shall meet the requirement of AWWA B100.

D. Oxidizer Delivery System

A Chemical feed system shall be provided for the delivery of potassium permanganate to the greensand filters. Metering pumps shall be supplied in accordance with Section 11317 "Specification for Controlled Volume Positive Displacement Pumps", Section 16405 "Specification for Induction Motors", and the metering pump data sheets. Vendor shall supply automatic electronic capacity control suitable for purchasers 4-20mA signal. Pump capacity shall be adjustable from 10% - 100% of full capacity. All motor starters shall be supplied by the purchaser.

E. Piping and Miscellaneous

All interconnecting piping shall be 316L stainless steel, shall have ANSI Class 150 raised face flanges, and shall be pressure rated per ANSI B31.3.

Skid fabrication/welding shall confirm to AWS D1.1.



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SPECIFICATION FOR GREENSAND FILTERS

2.0 PRODUCTS (continued)

Manual valves, instruments and electrical components shall be vendor's standard make and model. (Vendor shall provide a preliminary list of suppliers and the type/model number of the equipment, with the proposal.) All transmitters shall have a 4 - 20 mAdc signal on 24 VDC system.

Sample nozzles shall be mounted such that water samples may be secured at the following points:

- Immediately upstream of each filter unit.
- Immediately downstream of each filter unit.
- On each vessel shell between the anthracite and greensand media.
- 4" above the underdrain in each unit.

2.2.4 Preparation for Shipment

A. Each piece of equipment shall have a rustproof metal tag permanently attached to it and stamped with the following information:

- Manufacturer's name, model and type
- Rating and capacity
- The purchase order and equipment number

B. Flanged openings shall be covered with gaskets and rigid metal plates securely bolted. All threaded openings shall be plugged with stainless steel plugs. The ends of other loose piping shall be covered with waterproof paper and sealed with suitable tape.

C. All equipment shall be well packed in crates or containers or shall be mounted on hardwood skids and completely covered with polyethylene sheeting, as applicable. Moving parts shall be properly blocked to prevent movement during shipment. All instruments, control components, etc., shall have internals properly supported or separately packed to prevent damage during shipment. All loose items and/or small materials shall be shipped in strong wooden boxes and covered with waterproof sheeting. Each separate package shall be marked with Purchaser's Order Number and item number and shall contain a copy of the packing list describing contents.

3.4 All equipment shall be suitably packed for type of shipment, storage period and environment as specified. Vendor shall recommend necessary procedures for protection of equipment during shipment, unloading and storage.



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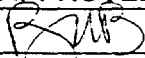
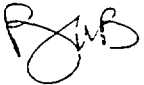
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SPECIFICATION FOR GREENSAND FILTERS			
3.0 EXECUTION			
Not used.			



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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00				NO. 11365	
				SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS	
BY	APPROVED	ISSUE DATE			
JEC		8/19/96			
<p>THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.</p> <p>FOR CONVENIENCE, THE NATURE OF THE REVISION IS BRIEFLY NOTED UNDER REMARKS. THESE REMARKS ARE NOT A PART OF THE DOCUMENT. THE REVISED PAGES ARE A PART OF THE DOCUMENT AND SHALL BE COMPLIED WITH IN THEIR ENTIRETY</p>					
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					SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
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1.0 GENERAL

1.1 SYSTEM DESCRIPTION

This specification establishes the minimum requirements for the design, fabrication, delivery, and placement into successful operation of a UV/Oxidation system for the destruction of organic compounds in water. The system shall be completely engineered and self contained and include all piping, instrumentation, control systems, electrical hardware, tankage and accessories for continuous automatic operation through a single system PLC located in the master control panel. The system shall also include equipment and accessories as required for the addition of one or more oxidizing agents which include ultraviolet light (UV). The vendor shall base the system design on the most cost effective oxidizing agent combination considering capital, operating and maintenance costs over the expected treatment life of the project.

1.2 RELATED SECTIONS

Section 16405 "Specification for Induction Motors"

Section 11317 "Specification for Controlled Volume Positive Displacement Pumps"

Section 13431 "Specification for Electrical Motor Valve Operators"

Section 16011 "Electrical Requirements for Package Equipment"

1.3 REFERENCE STANDARDS

The latest edition of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.3.1 American Society For Testing And Materials (ASTM)

ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS			
1.0 GENERAL (continued)			
ASTM A 530		Seamless and Welded Austenitic Stainless Steel Pipe.	
ASTM D 1785		Poly Vinyl Chloride (PVC) Plastic Pipe Schedules 40, 80, and 120	
1.3.2 American National Standards Institute (ANSI)			
ANSI B16.1		Cast Iron Pipe Flanges and Flanged Fittings	
ANSI B16.5		Steel Pipe Flanges and Flanges Fittings	
ANSI B31.1		Chemical Plant & Petroleum Refining Piping	
ANSI/AWS D1.1		Structural Welding Code	
1.3.3 American Society Of Mechanical Engineers (ASME)			
ASME Section VIII Div 1		Boiler and Pressure Vessel Code	
1.3.4 National Electric Code (NEC)			
1.3.5 Occupational Safety And Health Act (OSHA)			
1.4 QUALITY ASSURANCE			
1.4.1 A functional test of the system's control devices shall be conducted at vendor's facility. The test shall be witnessed by the purchaser or purchaser's representative.			



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS

1.0 GENERAL (continued)

1.4.2 A jobsite Acceptance Test ("TEST") shall be conducted to confirm that the system, when operated under the design conditions and in accord with the Operating and Maintenance Manuals, is functioning properly. Influent water quality shall contain organic constituents and inorganic compounds equivalent to those listed in the system data sheets. The Test will commence after completion of satisfactory system checkout and initial start-up operations. The system shall be operated for a four (4) hour period during which it will be tested to verify performance requirements. During the Test, the purchaser, or purchaser's representative shall perform operations and maintenance under vendor's surveillance. A plan to define instrument calibration requirements, chemical addition rates, measurement points, preservation methods, chemical laboratory selection, QA/QC procedures, and other necessary procedures shall be mutually agreed in writing no later than ten (10) working days prior to the Test. The Test Plan shall include provisions for taking of split samples as requested by Vendor (any analysis of vendors split is at vendors expenses). The purchaser is responsible for the analytical expenses they incur during the acceptance test. The system shall be deemed to have passed the Test when effluent water is treated to the design water quality requirement with the unit operated at the design flow rates. The Acceptance Test shall be conducted within thirty (30) days of start-up of the system.

1.5 SUBMITTALS

1.5.1 Drawings and Data

Approval drawings and data shall be submitted as indicated on the Vendor Drawing and Data Request (VDDR) form. Each drawing shall show the system tag number and name, purchase order number and client name. Data requirements include, but are not limited to, the following:

- A. Calculations which clearly support the scale-up of the proposed system; including the UV power requirement, chemical addition requirements, and system pressure drop.
- B. Calculations which estimate the operating cost of the proposed system.
- C. Structural calculations for the oxidation system shell(s), tanks, and mounting and support details.



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS			
1.0 GENERAL (continued)			
D. Drawings showing placement of the UV/Oxidation system relative to external piping, valves, and other equipment that must be interfaced.			
E. Details on all instrumentation and controls including make and model numbers.			
F. Complete list of equipment and materials, including manufacturers descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions.			
G. Material safety data sheets for all proposed chemicals.			
H. A description of any required procedures for storage and handling of the systems at the site.			
I. A complete list of parts, supplies and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply. A list of the parts recommended by the manufacturer to be replaced after 2 years of service. A priced list of commissioning spares.			
J. A complete set of wiring diagrams for all systems and controls and ladder logic for the PLC.			
K. A copy of the software used to program the PLC copied on diskette(s) suitable for reuse and for downloading to the PLC.			
L. Test reports in booklet form showing all field tests performed to demonstrate compliance with the specified performance criteria, upon completion and testing of the installed system.			
M. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering as appropriate, in the State in which the system was fabricated, stating that: 1) The fabrication drawings, pressure calculations for the shells and tanks, and seismic design calculations were designed for the listed conditions in accordance with the appropriate codes and standards. 2) The erection drawings for the shells and supports were designed for the listed conditions in accordance with the appropriate codes and standards.			



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS			
1.0 GENERAL (continued)			
1.5.2 Instructions			
Instructions and field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the equipment.			
1.5.3 Operations And Maintenance Manuals			
The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.			
2.0 PRODUCTS			
2.1 GENERAL			
All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.			
2.2. DESIGN			
2.2.1 Performance			
The system shall be designed to function as shown on the piping and instrument diagrams and as detailed in this specification. System performance requirements and influent water quality are shown on the UV/Oxidation system data sheets. The general system orientation is depicted on the equipment arrangement drawing.			
2.2.2 Materials			
Welded components which are wetted shall be 316L stainless steel. Non-welded components which are wetted shall be either 316L stainless steel or fiberglass reinforced plastic (FRP) (constructed of resin based on chlorenoic polyester: Ashland Chemical Hedron 19.7 or equal).			



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS

2.0 PRODUCTS (continued)

Stainless steel surfaces shall not be painted. Iron and steel surfaces shall be primed and painted with the manufacturer's standard coating system material and color.

Gaskets shall be EPDM, hypalon, fluorocarbon, or teflon.

2.2.3 Equipment

A. UV/Oxidation System

The manufacturer shall furnish all tools, materials, labor, and appurtenances necessary for the complete fabrication, testing, and shipment of the UV/Oxidation system.

All equipment shall be new and unused, except for final check-out testing.

The UV/Oxidation system shall consist of skid mounted reactor assemblies, power supplies, reagent delivery equipment, and programmed process control system. The reactor assembly shall be factory assembled and tested and ready for installation.

Each UV/Oxidation skid shall be capable of completely independent operation from other skids using the system PLC located in the master control panel.

B. UV/Oxidation Treatment Tank

The treatment tank shall be designed to efficiently and adequately distribute and process the water throughout the entire treatment tank as necessary to eliminate any uneven flow pattern or short circuiting.

The treatment tank shall be equipped with a sufficient number of UV lamps which emit UV at the wavelengths compatible with oxidants applied to meet the treatment requirements.

All UV lamps shall be contained within quartz tubes which are designed to allow transmittance of UV light while protecting the UV lamps from the liquid environment within the tank.

UV sensitive materials shall be completely shielded from direct or indirect contact with UV light.



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS			
2.0 PRODUCTS (continued)			
<p>The UV treatment tanks equipped with medium pressure UV lamps shall be equipped with automatic sheath cleaning mechanisms, if available.</p> <p>All UV lamps shall be individually removable from the UV/Oxidant treatment tank without draining or diverting the flow of the water from the tank.</p> <p>The UV/Oxidation treatment tank material of construction shall be resistant to the untreated and treated solution and to the environment within it.</p> <p>The UV/oxidation treatment tank shall be equipped with easily accessible valved influent and effluent sampling ports.</p> <p>Means shall be provided to drain the UV/Oxidation treatment tank</p> <p>Control shall be provided to allow on/off operation of individual medium pressure UV lamps or banks of low pressure UV lamps.</p> <p>A system to indicate the operating status of each lamp shall be provided in the master control panel.</p> <p>The UV lamps shall be driven by electronic ballasts which shall be housed in an enclosure. Ballast enclosures shall have limit switches which close when the ballast enclosure is closed.</p> <p>Ballasts shall be of the high-power factor type.</p> <p>The ballast enclosures shall have temperature activated switches which open when a ballast enclosure exceeds its maximum operating temperature.</p> <p>Each ballast enclosure shall be powered and controlled through a compartment containing appropriate starters, AC contactors, phase loss detector, safety disconnect switch and complementary hardware.</p>			
C. Power Supply			
<p>A power supply shall be provided for each UV lamp. The power supplies shall be installed in a NEMA 4X enclosure. All internal wiring must comply with NEC and be certified by a US OSHA accredited Nationally Recognized Testing Laboratory (NRTL). Efficiency of the power supplies must be at least 92% and the power factor must be at least 0.9 at full power.</p>			



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS

2.0 PRODUCTS (continued)

The power supply lamp starting sequence will be set to ensure an extended lamp life and to minimize inrush starting current. A system shall be provided to control lamp power through feedback of operating current and voltage to compensate for variations in supply voltage, system temperature changes, and lamp aging.

The power system shall be provided with cooling fans, thermal protection, safety access interlock, lamp run meters, lamp ammeters, lamp voltmeters, and main power disconnect. The power supply shall be equipped with transformers isolated from ground to provide inherent safety from electrical shock. Ground fault protection is not acceptable.

Each skid shall be wired for purchaser's single 480 volt/3-phase/60 Hz power drop. A 480VAC/120VAC transformer shall be provided by vendor to supply low voltage control devices. All control and interlocking circuitry shall be a maximum of 24 VDC.

All wiring and electrical components within the system shall be designed and installed in accordance with the latest edition of the National Electric Code and all applicable state and local codes.

D. Reagent Delivery Systems

A chemical feed system shall be provided for the delivery of the required oxidation chemicals to the UV/Oxidation system.

Dual hydrogen peroxide metering pumps shall be provided.. The capacity of the pumps shall be manually adjustable from 10% to 100% of full capacity. Pumps shall be supplied in accordance with Section 11317 "Specification for Controlled Volume Positive Displacement Pumps", and Section 16405 "Specification for Induction Motors". Motor starters shall be supplied by the purchaser in the Plant MCC.

Wetted pump materials shall be suitable for continuous contact with either 50% or 35% hydrogen peroxide solutions.

The hydrogen peroxide feed system shall be skid mounted and provided with secondary containment.



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS			
2.0 PRODUCTS (continued)			
E. UV/Oxidation Control System			
<p>A master control panel (NEMA 4X) shall be provided for the system. All controls/lights shall be clearly marked with phenolic, or equal name tags. The panel shall allow for:</p> <ul style="list-style-type: none">• On/off/auto operation of individual UV systems• On/off/auto operation of individual hydrogen peroxide feed pumps• Visual statusing (indicating lamps) of system for on/off/alarm• Control/Statusing of system from purchaser's plant PLC through serial communication. <p>The control system shall permit testing of all equipment while the system is off-line for maintenance.</p> <p>Each UV/Oxidation skid shall have a NEMA 4X junction box where all instruments will be a terminated. All wiring between the master control panel and UV/Oxidation skids will be supplied by the purchaser.</p> <p>Interlocks shall be provided to alarm and shut down the system under the following conditions:</p> <ul style="list-style-type: none">• High temperature in the lamp drive enclosure• High temperature in the UV/Oxidation reactor.• Reactor access covers open.• High lamp temperature. <p>Interlocks shall be provided to alarm only under the following conditions:</p> <ul style="list-style-type: none">• Low flowrate from UV/Oxidation reactor• Lamp failure• Metering pump and/or gas generation equipment failure• High tank pressure (if gas added)• Lamp wiper failure (if equipped with sheath cleaning mechanism)			
F. Piping			
<p>All interconnecting piping shall be 316L stainless steel, shall have ANSI Class 150 raised face flanges, and shall be pressure rated per ANSI B31.1.</p>			



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SPECIFICATION FOR UV/OXIDATION TREATMENT SYSTEMS			
2.0 PRODUCTS (continued)			
2.2.4 Preparation For Shipment			
A. Each piece of equipment shall have a stainless steel tag permanently attached to it and stamped with the following information:			
<ul style="list-style-type: none">• Manufacturer's name, model and type• Rating and capacity• Purchase Order and Equipment numbers			
B. All components shall be painted with manufacturer's standard paint. All moving and machined parts surfaces shall be coated with manufacturer's standard rust preventive compounds.			
C. Flanged openings shall be covered with gaskets and rigid metal plates securely bolted. All threaded openings shall be plugged with stainless steel plugs. The ends of other loose piping shall be covered with waterproof paper and sealed with suitable tape.			
D. All equipment shall be well packed in crates or containers or shall be mounted on hardwood skids and completely covered with polyethylene sheeting. Moving parts shall be properly blocked to prevent movement during shipment. All instruments, control components, etc., shall have internals properly supported or separately packed to prevent damage during shipment. All loose items and/or small materials shall be shipped in strong wooden boxes and covered with waterproof sheeting. Each separate package shall be marked with Purchaser's Order Number and item number and shall contain a copy of the packing list describing contents.			
E. Caution tags shall be attached to the unit to indicate where VPI paper and blocking of moving parts must be removed prior to installation.			
F. All equipment shall be suitably packed for type of shipment, storage period and environment as specified. Vendor shall recommend necessary procedures for protection of equipment during shipment, unloading and storage.			
3.0 EXECUTION			
Not used.			

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MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K-784-00

NO. 11367

SPECIFICATION FOR
ACTIVATED CARBON ADSORPTION
UNITS

BY	APPROVED	ISSUE DATE
JEC		8/19/96

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BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS	
JEC		8/19/96	0	8/19/96		

1.0 GENERAL

1.1 SYSTEM DESCRIPTION

This specification establishes the minimum requirements for the design, fabrication, delivery, and placement into successful operation of a liquid-phase activated carbon adsorption system for the removal of organic compounds from water. The system shall be completely engineered to the degree shown on the piping and instrument diagrams and shall include all interconnecting piping, valves, instrumentation, electrical hardware, vessels and accessories for continuous operation.

1.2 RELATED SECTIONS

Section 09900 "Shop and Field Coating"

Section 16011 "Electrical Requirements for Package Equipment"

JEG NO. 13-000 "Pressure Vessels Carbon & Low Alloy Steel"

JEG NO. 39-001 "General Welding Requirements for Pressure Equipment"

1.3 REFERENCE STANDARDS

The latest edition of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.3.1 American Society For Testing And Materials (ASTM)

ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 530	Seamless and Welded Austenitic Stainless Steel Pipe.
ASTM D 1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe Schedules 40, 80, and 120



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS			
1.0 GENERAL (continued)			
1.3.2 American National Standards Institute (ANSI)			
ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings			
ANSI B16.5 Steel Pipe Flanges and Flanges Fittings			
ANSI B31.3 Chemical Plant and Petroleum Refinery Piping			
ANSI/AWS D1.1 Structural Welding Code			
1.3.3 American Society Of Mechanical Engineers (ASME)			
ASME Section VIII Div 1 Boiler and Pressure Vessel Code			
1.3.4 National Electric Code (NEC)			
1.3.5 Occupational Safety And Health Act (OSHA)			
1.4 QUALITY ASSURANCE			
1.4.1 A jobsite Acceptance Test ("TEST") shall be conducted to confirm that the system, when operated under the design conditions and in accord with the Operating and Maintenance Manuals, is functioning properly. Influent water quality shall contain organic constituents and inorganic compounds equivalent to those listed in the system data sheets. The Test will commence after completion of satisfactory system checkout and initial start-up operations. The system shall be operated for a four (4) hour period during which it will be tested to verify performance requirements. During the Test, the purchaser, or purchaser's representative shall perform operations and maintenance under vendor's surveillance. A plan to define instrument calibration requirements, measurement points, preservation methods, chemical laboratory selection, QA/QC procedures, and other necessary procedures shall be mutually agreed in writing no later than ten (10) working days prior to the Test. The Test Plan shall include provisions for taking of split samples as requested by Vendor (any analysis of vendor's split is at vendor's expenses). The purchaser is responsible for the analytical expenses they incur during the acceptance test. The system shall have been deemed to have passed the Test when effluent water is treated to the design water quality requirement with the unit operated at the design flow rates. The Acceptance Test shall be conducted within thirty (30) days of start-up of the system.			



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

1.0 GENERAL (continued)

1.5 SUBMITTALS

1.5.1 Drawings and Data

Approval drawings and data shall be submitted as indicated on the vendor drawing and data request (VDDR) form. Each drawing shall show the system tag number and name, purchase order number and client name. Data requirements include, but are not limited to, the following:

- A. Calculations which clearly support the scale-up of the proposed system; including the carbon bed depth and volume requirements, and system pressure drop. Calculations showing anticipated carbon usage.
- B. Structural calculations for the system shell(s) and mounting and support details.
- C. Drawings showing placement of the system relative to external piping, valves, and other equipment that must be interfaced.
- D. Details on all instrumentation and controls including make and model numbers.
- E. Complete list of equipment and materials, including manufacturers descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions.
- F. A description of any required procedures for storage, handling, and installation of the systems at the site.
- G. A complete list of parts, supplies and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply. A list of the parts recommended by the manufacturer to be replaced after 2 years of service. A priced list of commissioning spares.
- H. Test reports in booklet form showing all field tests performed to demonstrate compliance with the specified performance criteria, upon completion and testing of the installed system.



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

1.0 GENERAL (continued)

I. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering as appropriate, in the State in which the system was fabricated, stating that: 1) The fabrication drawings, pressure calculations for the shells and tanks, and seismic design calculations were designed for the listed conditions in accordance with the appropriate codes and standards. 2) The erection drawings for the shells and supports were designed for the listed conditions in accordance with the appropriate codes and standards.

1.5.2 Instructions

Instructions and field procedures for erection, adjustments, inspection, maintenance and testing shall be provided prior to installation of the equipment.

1.5.3 Operations And Maintenance Manuals

The vendor shall supply operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides shall also be included.

2.0 PRODUCTS

2.1 GENERAL

All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable Manufacturers specializing in the manufacture of such products; such Manufacturers shall have had previous experience in such manufacture and shall, upon request of the Contractor, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS			
2.0 PRODUCTS (continued)			
2.2. DESIGN			
2.2.1 Performance			
<p>The system shall be designed to function as shown on the piping and instrument diagram and as detail in this specification. The system shall be designed for operating in the series downflow mode and be capable of independent backwashing for each unit. System performance requirements and influent water quality are shown on the activated carbon system data sheets. The general orientation of the system is depicted on the equipment arrangement drawing.</p>			
2.2.2 Materials			
<p>A general overview of the system materials of construction is as follows:</p>			
A. Process Piping - A53 Grade B or A106 Grade B Carbon Steel			
B. Carbon Supply and Return Piping - Polypropylene Lined A53 Grade B or A106 Grade B Carbon Steel			
C. Vessels - A516 70 (Lined internally with manufacturer's standard corrosion and abrasion resistant lining)			
D. Fabricated Steel Structures - A36 (or manufacturer standard)			
2.2.3 Equipment			
A. Freestanding vessels with skid mounted/interconnecting piping are envisioned. This arrangement is not mandatory, however, the objective is to minimize field assembly, piping fabrication and wiring where possible. Regardless of the design approach, the entire system must be contained within the plot limits shown on the equipment arrangement drawing. Where the skid approach is used, all instrument devices shall be prewired and terminated at edge of skid in a NEMA 4X junction box. Skid piping terminations shall be flanged and shall be brought to the edge of skid.			



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

2.0 PRODUCTS (continued)

- B. Each adsorber vessel shall be a vertical cylindrical vessel with ellipsoidal bottom and head. Each adsorber vessel shall be designed to contain the required amount of granular activated carbon with freeboard above the bed. The freeboard shall be no less than 20% of the volume of the carbon. The vessels shall be constructed of A-516 grade 70 pressure vessel quality carbon steel plate and shall be designed, constructed, tested, certified, and National Board registered in accordance with the most recent revision of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. The vessel shall be supported with structural steel legs with drilled base plates such that the vessels can be adequately and safely bolted to a concrete pad. The interior surfaces of the vessel shall have all welds and any other sharp edges ground smooth and all imperfections such as skip welds, delaminations, scabs, slivers, and slag shall be corrected prior to lining. All welds will be ground to a radius compatible to the lining and shall be free of porosity.

The interior of each adsorber vessel shall be lined in order to prevent corrosion. This lining shall exhibit abrasion resistant qualities to prevent erosion by movement of the granular media. The coating shall be as manufactured by Wisconsin Protective Coatings Plasite 4110 with a nominal dry film finished thickness of between 35 - 45 mils, or approved equal. The adsorber internal surface including all nozzles shall be blasted a white metal surface (SSPC-SP5) to provide an anchor pattern in the metal corresponding to approximately 20% - 25% of the film thickness of the coating. All wetted surfaces will be lined with Plasite 4110.

- C. The necessary process piping shall include all valves and fittings to enable the adsorbers to be operated in downflow series mode with either bed as the lead bed. All lines, valves and instruments shall be labeled and tagged with stainless steel tags. The piping shall be assembled to the greatest extent possible for delivery to jobsite.
- D. The maximum allowed pressure drop is indicated on the data sheet. The pressure drop across the system shall be calculated including system piping, underdrains and carbon and when operating at system capacity in the series mode with all adsorber vessels in service with clean carbon beds.



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS			
2.0 PRODUCTS (continued)			
<p>E. A collection system shall be provided in the bottom section of the carbon bed to collect treated waste across the carbon bed cross section. The water velocity profile across the diameter of each bed shall be uniform in the downward direction of the underdrain location. The collection device shall be 316L stainless steel vertical screens. The screens shall be designed to retain carbon and allow free passage of treated water to be directed at minimum pressure drop to an external collection header from which the treated water shall be conveyed via piping to the second stage adsorber. All adsorbers shall be provided with the identical underdrain design.</p> <p>In no case will material foreign to carbon, i.e.: sand, gravel or concrete be installed inside the vessel to assist in treated water collection underdrain. <u>Designs incorporating plastic pipes, plastic distribution nozzles and laterals with support plates and screens within the vessel will not be considered.</u> The vessel internals shall be structurally sound and capable of withstanding the pressure exerted during backwashing and carbon transfer operations.</p>			
<p>F. Manways</p> <p>Each adsorber shall be provided with one (1) manway located on the vessel shell just above the point where the bottom section connects with the vessel straight side (above tangent line). The manway shall be a quick opening manway with EPDM saline closure type gasket and zinc plated swing bolts with zinc plated nuts and washer. Round bolted manways will not be acceptable.</p>			
<p>G. Bed Sample Inserts</p> <p>One (1) flanged sample tap nozzle shall be provided along the vertical shell of each adsorber vessel. Sample nozzles shall consist of a 2 inch 150 pound raised face flange. The sample insert shall be a 3/8" diameter pipe 13" long with four (4) inches of the thirteen (13) inch length being a screened section of 0.01" slot opening 316L wedge wire screen. The other end will be a wafer flange. The insert will be sandwiched between the tank nozzle and a tapped blind flange utilizing 1/8" thick full face EPDM gaskets. The blind flange tap will be 1/2" NPT for connection to 1/2" diameter 316 stainless steel sample tubing equipped with 1/2" NPT regular port 316 stainless steel ball valves. The sample tap shall also include a pressure gauge connection and a pressure gauge.</p>			



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

2.0 PRODUCTS (continued)

H. Abrasion Resistant Inserts

The carbon inlet and outlet nozzles on each adsorber shall be equipped with a removable/replaceable abrasion insert to protect the lining at the nozzle from deterioration and wear during carbon slurry transfers to and from the vessel. The insert shall be manufactured out of 316L stainless steel and shall be of the wafer type such that it can be sandwiched between two (2) 6" 150 pound flat face flanges. The insert shall extend into the nozzle and have an overall length of 6" from the face of the flange. Gasketing on either side of the insert shall be 1/8" thick full face EPDM gasket. A total of two (2) inserts will be supplied per vessel.

I. Adsorber Designation and Labels

Each adsorber vessel shall have a stenciled label with a warning sign stating that the vessel interior is lined and that no welding to the vessel will be permitted. The sign shall read:

"LINED VESSEL"
"DO NOT WELD, BURN OR SHOCK"

Each adsorber shall have a 8 1/2" x 11" mylar laminate over vinyl warning label located adjacent to the manway. The label shall read as follows:

WARNING

"POSSIBLE LOW OXYGEN CONTENT EXISTS IN VESSEL. TAKE
ALL OSHA PRECAUTIONS FOR CONFINED SPACE ENTRY."

2.2.4 PIPING

Process piping shall be provided to the two (2) adsorbers to enable the following functions to be performed.



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

2.0 PRODUCTS (continued)

Under normal operation, the maximum design flow shall be accepted at the system limits and directed to the two (2) adsorbers operating in the two stage series mode. Treated water piping shall incorporate Schedule 40 carbon steel flanged piping. Lever operated cast iron butterfly valves shall be provided to enable the sequencing of the adsorbers in the series mode of operation. The valves shall enable isolation of any one adsorber while the other is being recharged with fresh carbon. The piping shall be oriented such that for a set of adsorbers, either adsorber can be placed in the "lead bed" mode with the second adsorber in the "polish bed" mode.

A. Adsorber Backwash

The piping shall enable the vessels to be back washed should an unacceptable pressure drop develop across the carbon bed due to introduction of filterable solids, biological activity or gas pockets in the bed. In case of backwash, the vessel being backwashed shall be isolated from the process flow, as during the carbon replacement procedure. Alternatively, the system shall also permit the utilization of treated water from one adsorber to be directed up flow through the other. The system should be provided with 150# flanged connections to enable the design capacity of water in upflow through the adsorbers. The backwash return water containing particulate impurities upon exiting the top of the adsorber will be directed via backwash return piping on each adsorber.

B. Sample Piping

The following sample taps will be provided as a minimum:

- Influent water to each adsorber pair.
- Treated water from each adsorber pair.
- Treated water between each adsorber pair.
- Backwash line from each adsorber pair.
- 80% depth point on each vessel.



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

2.0 PRODUCTS (continued)

The influent to each adsorber, treated water from each adsorber and bed depth sample piping shall be 1/2" diameter with 316 stainless steel trim ball valves. The bed depth sample lines will be tubed to an accessible location adjacent to each adsorber. Sample taps on the influent and effluent from each adsorber shall be local sample points. Every sample point shall be provided with a pressure gauge connection.

2.2.5 Granular Activated Carbon

Granular activated carbon furnished and installed for initially filling the adsorber vessels shall be as specified herein. Initial carbon charge shall be supplied by vendor.

A. The granular activated carbon shall be a material manufactured from select grade of bituminous coal only. The activated carbon must possess superior hardness and abrasion characteristics to withstand pneumatic and hydraulic transfers and handling without significant change in physical size or loss of carbon volume.

B. The granular activated carbon shall be supplied by system supplier who is experienced in the application of granular activated carbon for the application.

C. The granular activated carbon's physical size and density must be such that it shall flow readily within the fresh and spent granular activated carbon transfer piping provided with the system and must form a workable slurry with a concentration of approximately two (2) pounds of carbon per gallon of water.

D. The activated carbon shall be as specified by the vendor to meet the process conditions. Vendor shall supply physical properties for the selected carbon, including:

Base Material Description; Iodine Number; Abrasion Number (RO-Tap Method); Moisture %; Water Soluble Ash %; Particle Size (U.S. Sieve Size); Oversize %; Undersize %; Mean Particle Diameter; Effective Size; Apparent Density (before and after backwashing); Total Ash %; Uniformity Coefficient



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SPECIFICATION FOR ACTIVATED CARBON ADSORPTION UNITS

2.0 PRODUCTS (continued)

2.2.6 Preparation For Shipment

A. Each piece of equipment shall have a stainless steel tag permanently attached to it and stamped with the following information:

- Manufacturer's name, model and type
- Rating and capacity
- The purchase order and equipment number

B. Flanged openings shall be covered with gaskets and rigid metal plates securely bolted. All threaded openings shall be plugged with stainless steel plugs. The ends of other loose piping shall be covered with waterproof paper and sealed with suitable tape.

C. All equipment shall be well packed in crates or containers or shall be mounted on hardwood skids and completely covered with polyethylene sheeting, as applicable. Moving parts shall be properly blocked to prevent movement during shipment. All instruments, control components, etc., shall have internals properly supported or separately packed to prevent damage during shipment. All loose items and/or small materials shall be shipped in strong wooden boxes and covered with waterproof sheeting. Each separate package shall be marked with Purchaser's Order Number and item number and shall contain a copy of the packing list describing contents.

D. Caution tags shall be attached to the unit to indicate where VPI paper and blocking of moving parts must be removed prior to installation.

E. All equipment shall be suitably packed for type of shipment, storage period and environment as specified. Vendor shall recommend necessary procedures for protection of equipment during shipment, unloading and storage.

3.0 EXECUTION

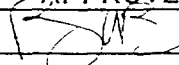

Not used.

DIVISION 13



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

®

AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00				NO. 13121	
				SPECIFICATION FOR PRE-ENGINEERED BUILDING	
BY MH	APPROVED 	ISSUE DATE 8/23/96			
<p>THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.</p> <p>FOR CONVENIENCE, THE NATURE OF THE REVISION IS BRIEFLY NOTED UNDER REMARKS. THESE REMARKS ARE NOT A PART OF THE DOCUMENT. THE REVISED PAGES ARE A PART OF THE DOCUMENT AND SHALL BE COMPLIED WITH IN THEIR ENTIRETY.</p>					
REV.	DATE	BY	APPROVAL	PAGES	REMARKS
0	08/23/96	MH		All	Issued for Construction



AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO.: 35-K784-00

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SPECIFICATION FOR
PRE-ENGINEERED BUILDING

BY	APPROVED	ISSUE DATE	REV. NO.	DATE
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1.0 GENERAL

1.1 Description

- A. This Section describes the design, manufacture and erection of the pre-engineered building as shown on the drawings.
- B. The building size and general configuration shall be as shown on the drawings.

1.2 Work by Others:

- A. Construction of foundation and placement of anchor bolts.

1.3 Related Sections

- 1. Section (08110) Steel Doors and Frames
- 2. Section (08330) Overhead Doors
- 3. Section (08710) Finish Hardware
- 4. Section (09901) Architectural Painting

1.4 References (Latest Edition)

- 1. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
- 2. ASTM A36 Structural Steel
- 3. ASTM A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware
- 4. ASTM A307 Carbon Steel Externally Threaded Standard Fasteners
- 5. ASTM A325 High Strength Bolts for Structural Steel Joints
- 6. ASTM A386 Zinc-coating (Hot-Dip) on assembled Steel Products
- 7. UBC-94 "Uniform Building Code" 1994



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SPECIFICATION FOR PRE-ENGINEERED BUILDING			
1.0 <u>GENERAL</u> (continued)			
	8.	ASTM D2244	Instrumental Evaluation of Color Differences of Opaque Materials.
	9.	ASTM A446	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (physical) Quality.
	10.	ASTM A490	Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints.
	11.	ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
	12.	ASTM A501	Hot Formed Welded and Seamless Carbon Steel Structural Tubing.
	13.	ASTM A525	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements.
	14.	ASTM A529	Structural Steel with 42,000 psi (290 MPa) Minimum Yield Point.
	15.	ASTM A572	High Strength Low Alloy Columbium-Vanadium Steel of Structural Quality.
	16.	ASTM C665	Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
	17.	AWS A2.0	Standard Welding Symbols
	18.	AWS D1.1	Structural Welding Code
	19.	FS HH-I-521	Insulation Blankets, Thermal, Mineral Fiber
	20.	FS HH-I-558	Insulation, Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)
	21.	SSPC	Steel Structures Painting Council
1.5 <u>System Description</u>			
	1.	Rigid frame with insulated walls and insulated gable roof.	



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SPECIFICATION FOR
PRE-ENGINEERED BUILDING

1.0 GENERAL (continued)

1.6 Design Requirements

A. General

Completed buildings shall be fabricated to provide completed structures free of excessive noise from wind-induced vibrations under ordinary weather conditions, and in accordance with requirements of the Metal Building Manufacturers Associated "Recommended Design Practices Manual," current issue, excepting the following qualifications:

1. Structural Steel: Structural steel shall be designed in accordance with the latest edition of AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," and with the latest edition of AISI "Specification for Design of Cold-Formed Steel Structural Members."
2. Loadings: Building shall be designed for the dead load, the specific live loads, and the combinations of these loads as specified in UBC 1994. Reduction of load due to tributary loaded area will not be permitted. In addition to dead load, the following loads shall be included:

Live Load: Roof live load 20 pounds per square foot on horizontal projection.

Wind Load: Based on UBC 1994
Velocity: 100 mph
Exposure Factor: C
Category: 4
Importance Factor: 1.0

Auxiliary Loads: Include uniform load of 10 psf to allow "For Weight of Mechanical and Electrical Equipment" and concentrated loads as shown on the drawings.

Seismic Load: Based on UBC 1994
Zone: 2A
Soil Profile Coff: 1.2
Importance Factor: 1.0



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**SPECIFICATION FOR
PRE-ENGINEERED BUILDING**

1.0 GENERAL (continued)

Snow Load: Based on UBC 1994
 Basic Ground Snow Load: 30 psf
 Snow Exposure Factor: 0.9
 Importance factor: 1.0

3. Framed Openings: Framed openings shall be designed to replace structurally the covering and framing displaced. Include door openings for all doors specified hereinafter.

4. Welding of Steel: Welding shall be in accordance with AWS D1.1.

5. Deflections: Maximum live load deflection of roof sheets shall not exceed 1/180th span between supports. Maximum deflections shall be based on sheets continuous across two or more supports with sheets fastened and fully free to deflect. Roof purlins shall have a depth not less than 1/40 span. Roof purlins shall have maximum live load deflection not greater than 1/180 span.

1.7 Submittals

 A. Shop Drawings

 For all metal building designs, the shop drawings shall be accompanied by engineering design calculations for structural and covering components, signed by a registered professional engineer licensed to practice in the state where the project is located. For computer programmed designs, shop drawings shall be accompanied by stress values and a certificate, signed by a registered professional engineer licensed to practice in the state where the project is located, stating design criteria and procedures used, listing input-output descriptions, and attesting to the adequacy and accuracy of the design. The shop drawings shall have the following minimum information:

1. Indicate wall and roof system dimension, panel layout, general construction details, anchorages and method of anchorage, method or installation.

2. Indicate framing anchor bolt settings, sizes, and locations from datum and foundation loads.



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**SPECIFICATION FOR
PRE-ENGINEERED BUILDING**

1.0 **GENERAL** (continued)

3. Indicate welded connections with AWS A2.0 welding symbols. Indicate net weld lengths.

4. Product Data: Provide data on profiles, components dimensions and fasteners.

5. Manufacturer's standard range for each roof and wall profile.

6. Manufacturer's installation instructions, indicating preparation requirements and assembly sequence.

1.8 **Quality Assurance**

A. Fabricate structural steel members in accordance with AISC - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

1.9 **Qualifications**

A. Manufacturer: Company specializing in manufacturing the products specified in the Section with the minimum of five years documented experience.

B. Design structural components under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the place where the Project is located.

C. Design work under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the place where the Project is located.

1.10 **Regulatory Requirements**

A. Conform to applicable Uniform Building Code for submission of design calculations reviewed shop drawings and Life, Safety Code as required for acquiring permit.

B. Cooperate with regulatory agency or authority and provide data as requested.



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**SPECIFICATION FOR
PRE-ENGINEERED BUILDING**

1.0 **GENERAL** (continued)

1.11 **Warranty**

A. **Building Warranty**

All buildings shall be guaranteed against water leaks arising out of or caused by ordinary wear and tear by the elements for a period of five years. Leaks caused by hurricane, lightning, tornado, gale, hail storm or other unusual phenomena shall not be deemed to be ordinary wear and tear by the elements.

B. **Finish**

The finish on exterior exposed surfaces of roof and wall sheets and the accessories shall be guaranteed for a period of 20 years against blistering, peeling, cracking, flaking, chalking, and chipping and that the color will not change in excess of 5 N.B.S. units as determined in accordance with ASTM D 2244.

2.0 **PRODUCTS**

2.1 **Materials - Framing**

A. Structural Steel Members: ASTM A572, Grade 50.

B. Structural Tubing: ASTM A500, Grade B

C. Plate or Bar Stock: ASTM A529.

D. Anchor Bolts: ASTM A307, galvanized to ASTM A386, Class B.

E. Bolts, Nuts, and Washers: ASTM A325, galvanized to ASTM A153.

F. Welding Materials: AWS D1.1; type required for materials being welded.

G. Primer: Hot dipped galvanized.

H. Grout: Non-shrink type, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 2400 psi in two days and 7000 psi in 28 days.



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SPECIFICATION FOR
PRE-ENGINEERED BUILDING

2.0 **PRODUCTS** (continued)

2.2 **Materials - Wall and Roof System**

- A. Sheet Steel Stock: ASTM A446, Grade A with a galvanized coating conforming to ASTM A525, Grade 90 designation.
- B. Insulation: FS HH-I-521, FS HH-I-558, ASTM C665, glass fiber type, faced with reinforced white vinyl UL flame spread classification of 25 or less, friction fit, smoke spread less than 40.
- C. Joint Seal Gaskets: Manufacturer's standard.
- D. Fasteners: Manufacturer's standard type, galvanized to ASTM A386 1.25 oz/sq ft finish to match adjacent surfaces when exterior exposed.
- E. Sealant: Manufacturer's standard, non-staining, elastomeric.

2.3 **Plastic Skylight**

- A. Single Dome: Acrylic plastic, clear
- B. Nominal Size: As scheduled on the drawings
- C. Unit Frame: Extruded aluminum, thermally broken, integral curb frame with integral condensation drainage gutter.
- D. Support Curb: Aluminum sandwich construction with flange for anchorage to roof deck.

2.4 **Fabrication - Wall and Roof Systems**

- A. Siding: shall be 24 gauge minimum metal thickness, with configurations for interlocking ribs for securing adjacent sheets, concealed fastener system.



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SPECIFICATION FOR PRE-ENGINEERED BUILDING			
2.0 <u>PRODUCTS</u> (continued)			
B. Roofing: shall be 24 gauge minimum metal thickness, standing seam configuration. Depth of configuration shall be the building manufacturer's standard provided all design criteria are met.			
C. Liner: shall be 24 gauge minimum metal thickness, flat profile.			
D. Soffit Panels: shall be 24 gauge minimum metal thickness, V crimped profile, perforated for ventilation.			
E. Girts/Purlins: Rolled formed structural shape to receive siding, roofing and liner sheet.			
F. Internal & External Corners: Same material thickness and finish as adjacent material, profile (brake formed) shop cut and factory mitered to required angles. Back brace mitered internal corners with 22 gauge thick sheet.			
G. Expansion Joints: Same material and finish as adjacent material where exposed, 22 gauge thick, (manufacturer's standard brake formed) (infill) type, of profile to suit system.			
H. Flashing, Closure Pieces, Facia, Infills and Caps: Same material and finish as adjacent material, profile to suite system.			
I. Fasteners: To maintain load requirements, and weathertight installation, same finish as cladding, non-corrosive finish.			
J. Ventilator: Gravity type, low profile complete with base, bird screen, hood and flashing.			
K. Wall Louvers: Type "Z" blade design, same finish as adjacent material with steel mesh bird screen and frame.			
2.5 <u>Fabrication - Gutters and Downspouts</u>			
A. Fabricate of same material and finish as roofing metal.			
B. Form gutters and downspouts and scuppers of profile and size indicated to collect and remove water. Fabricate with connection pieces.			



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**SPECIFICATION FOR
PRE-ENGINEERED BUILDING**

2.0 **PRODUCTS** (continued)

- C. Form sections in maximum possible lengths. Hem exposed edges. Allow for expansion at joints.
- D. Fabricate support straps of same material and finish as roofing metal, color as selected.

2.6 **Finishes**

- A. Framing Members: clean, prepare, and galvanize to ASTM A386, Class B.
- B. Exterior Surfaces of Wall and Roof Components and Accessories: Precoated enamel on steel of modified silicone finish, color as selected from manufacturer's standard range.
- C. Interior Surfaces of Wall and Roof Component and Accessories: Precoated enamel on steel of modified silicone finish, color as selected from manufacturer's standard range.
- D. Vinyl Vapor Barrier at Interior Face of Insulation: White.

3.0 **EXECUTION**

3.1 **Examination**

- A. Verify site conditions.
- B. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position.

3.2 **Erection - Framing**

- A. Erect framing in accordance with AISC Specification.
- B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing. Locate braced bays as indicated.
- C. Set column base plates with non-shrink grout to full plate bearing.



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SPECIFICATION FOR PRE-ENGINEERED BUILDING			
3.0 <u>EXECUTION</u> (continued)			
D. Do not field cut or alter structural members without approval of Architect/Engineer.			
E. After erection, prime weld, abrasions, and surfaces not galvanized.			
3.3 <u>Erection - Wall and Roofing Systems</u>			
A. Install in accordance with manufacturer's instructions.			
B. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.			
C. Fasten cladding system to structural supports, aligned level and plumb.			
D. Locate end laps over supports. End laps minimum two inches. Place sidelaps over bearing.			
E. Provide expansion joints where indicated.			
F. Use concealed fasteners.			
G. Install insulation and vinyl vapor barrier utilizing clips or fasteners for attachment. Place wire mesh under vinyl for support between framing members.			
H. Install sealant and gaskets to prevent weather penetration.			
I. System: Free of rattles, noise due to thermal movement and wind whistles.			
3.4 <u>Erection - Gutter and Downspout</u>			
A. Rigidly support and secure components. Joint lengths with formed seams sealed water tight. Flash and seal gutters to downspouts.			
B. Apply bituminous paint on surfaces in contact with cementitious materials.			
C. Slope gutters minimum 1/4 inch/ft.			



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SPECIFICATION FOR
PRE-ENGINEERED BUILDING

3.0 EXECUTION (continued)

- D. Install splash pads.

3.5 Erection - Skylight

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate with installation of roofing system and related flashings.
- C. Apply bituminous paint on aluminum surfaces of units in contact with dissimilar metals.
- D. Provide weathertight installation.

3.6 Installation - Accessories

- A. Install door frame, door, overhead door, window and glass, in accordance with manufacturer's instructions.
- B. Seal wall and roof accessories watertight and weather tight with sealant in accordance with manufacturer recommendation.

3.7 Tolerances

- A. Framing Members: 1/4 inch from level; 1/8 inch from plumb.
- B. Siding and Roofing: 1/8 inch from true position.



Jacobs Engineering Group Inc.
Central Region
Houston, Texas

METAL BUILDING DESIGN CRITERIA (Exhibit A)

REFERENCE	1	JOB NO. 35-K784-04	BUILDING NAME TREATMENT UNIT NO. 1	SPEC. NO. 13121
	2	PLANT FUEL SPILL-12 MMR	NO. UNITS 1	BLDG. NO.
	3	ACCOUNT	VENDOR	PO. NO.
	4	AREA	REF. DWG. NO. FS12-1064-301	VPF NO.
	5	BY N. AI	CHKD	APPR. DATE 08-26-96 REV. A DATE 08-26-96
GENERAL	6	LOCATION: STATE MASSACHUSETT	COUNTY	TOWNSHIP CAPE COD
	7	<input type="checkbox"/> MATERIALS ONLY	<input checked="" type="checkbox"/> MAT'L AND ERECTION	FOUNDATION BY: <input type="checkbox"/> VENDOR <input checked="" type="checkbox"/> OTHERS
	8	ANCHOR BOLTS SUPPLIED BY:	<input type="checkbox"/> BUILDING VENDOR	<input checked="" type="checkbox"/> OTHERS
	9			
BASIC DIMENSIONS	10	LENGTH 153' 0"	FT. WIDTH 108' 0"	FT. EAVE HEIGHT 25.0 FT
	11	COLUMN SPACING CLTO CL INTERIOR BAYS	30.0 FT	END BAYS 21.0 FT
	12	INSIDE CLEARANCE	LENGTH 150.0 FT	HEIGHT 19.5 FT
	13	WIDTH 98 FT AT	19.5 FT. HEIGHT ABOVE FLOOR	
	14	SHEDS: <input type="checkbox"/> ONE SIDE <input type="checkbox"/> BOTH SIDES	HEIGHT OUTSIDE WALL	FT
	15	CLEAR INSIDE HEIGHT AT MAIN BUILDING WALL		
	16			
DESIGN LOADS	17	ROOF LIVE LOAD 30 PSF, UBC 94 LB/FT	ROOF COVERING LOAD LB/FT	FLOOR LOAD, MEZZANINE & MCC 200 LB/FT ²
	18	CONC. ROOF LOAD PIPE RACK LB (SEE DWG.)	WIND LOAD (30' ELEV.) 100 MPH, 6x6: 4 LB/FT	SEISMIC ZONE 2A, UBC 1994
	19	COLLATERAL LOADS (DEAD LOADS: PIPING, LIGHTING, EQUIPMENT)		
	20	10 PSF PLUS PIPE RACK LOADS SEE SKETCHES		
	21			
	22	AUXILIARY LOADS (DYNAMIC LOADS: CRANES, MATERIAL HANDLING SYS., IMPACT)		
	23	PIPE RACK SEE SKETCHES		
	24			
BUILDING COMPONENTS	25	STRUCTURAL <input checked="" type="checkbox"/> RIGID FRAME	<input type="checkbox"/> BEAM & COLUMN	<input type="checkbox"/> TRUSS FRAME <input type="checkbox"/> SELF FRAME
	26	STRUCTURAL STEEL COATING:	<input type="checkbox"/> SHOP PRIMED <input type="checkbox"/> SHOP PRIMED	<input checked="" type="checkbox"/> HOT DIP GALVANIZED INCLUDING GIRTS AND PURLINS
	27			
	28	ROOF: MINIMUM SLOPE 2 IN/FT	UL UPLIFT CLASS	<input type="checkbox"/> 30 <input type="checkbox"/> 60 <input checked="" type="checkbox"/> 90
	29	MATERIAL	COLOR	PER OWNER'S SELECTION
	30	<input type="checkbox"/> GA. GALVANIZED STEEL		
	31	<input type="checkbox"/> GA. ALUMINUM COATED STEEL		
	32	<input checked="" type="checkbox"/> 24 GA. STEEL COATED BOTH SIDES WITH MILS OF SEE SPECIFICATION 13121		
	33	<input type="checkbox"/> MFR. STD.	<input type="checkbox"/> OTHER	
	34	<input type="checkbox"/> SANDWICH INSULATED PANELS		
	35	<input type="checkbox"/> TRANSLUCENT PANELS (SEE DWG.)		
	36	<input checked="" type="checkbox"/> OTHER 10 SINGLE DOMES OF CLEAR ACRYLIC PLASTIC		
	37	<input type="checkbox"/> ROOF OPENINGS (SEE DWG.)	COLOR	
	38	WALL PANELS: MATERIAL		
	39	<input type="checkbox"/> GA. GALVANIZED STEEL		
	40	<input type="checkbox"/> GA. ALUMINUM COATED STEEL		
	41	<input checked="" type="checkbox"/> 24 GA. STEEL COATED BOTH SIDES WITH MILS OF SEE SPECIFICATION 13121		
	42	<input type="checkbox"/> MFR. STD.	<input type="checkbox"/> OTHER	
	43	<input type="checkbox"/> SANDWICH INSULATED PANELS		
	44	<input type="checkbox"/> TRANSLUCENT PANELS (SEE DWG.)		
	45	<input checked="" type="checkbox"/> OTHER (SPECIFY) 24 GAGE FLAT PROFILE STEEL COATED BOTH SIDES SEE SPEC. (PARTIAL LINER)		
	46	<input type="checkbox"/> WALL OPENINGS (SEE DWG.)		
	47	TRIM COLOR: <input checked="" type="checkbox"/> MFR. STD	<input type="checkbox"/> OTHER	
INTERIOR FINISH	48	INTERIOR FINISH: WHEN INTERIOR FINISH IS INDICATED (SEE DWG.), THE WALL AND/OR ROOF SHALL BE LINED WITH THE FOLLOWING:		
	49			
	50	PARTIAL LINER SEE DWGS.		
	51			
	52			
	53			
INSULATION	54	INSULATION		
	55	MATERIAL	R. VALUE	
	56	ROOF GLASS FIBER	3 INCHES	<input checked="" type="checkbox"/> VINYL <input type="checkbox"/> FOIL <input type="checkbox"/> KRAFT
	57	WALLS GLASS FIBER	3 INCHES	<input checked="" type="checkbox"/> VINYL <input type="checkbox"/> FOIL <input type="checkbox"/> KRAFT
	58			
	59			
	60			

REFERENCE	1	JOB NO. 35K78404 BUILDING NAME TREATMENT UNIT NO.1				SPEC. NO. 13121	
	2	PLANT FUEL SPILL - 12 MMR		NO. UNITS 1		BLDG. NO.	
	3	ACCOUNT		VENDOR		PO. NO.	
	4	AREA		REF. DWG. NO. FS12-1064-301		VPF NO.	
	5	BY NAI		CHKD		APPR.	
	6	DATE 08-26-96		REV. A		DATE 08-26-96	
	7	<input checked="" type="checkbox"/> PERSONAL DOORS, STEEL		<input type="checkbox"/> HD-1 3/4" THICK		<input type="checkbox"/> SD-1 5/8" THICK	
	8	SEE DWGS AND SPECIFICATION					
	9	NO		SIZE		GLAZING	
	10	10		3.00 x 7.00		SEE DWG, SPEC	
	11	1		6.00 x 7.00		SEE DWG, SPEC	
	12	1		8.00 x 8.00		SEE DWG, SPEC	
ACCESSORIES	13	LOCKS: A--MFR STD		B--KEY TO PLANT MASTER		C--OTHER	
	14	SEE SPEC		D--PANIC HWWR		E--DOOR CLOSURE	
	15	12		SEE DWG			
	16	<input checked="" type="checkbox"/> UTILITY DOORS:		NO		SIZE	
	17	<input type="checkbox"/> SLIDING				FIRE PROOF	
	18	<input checked="" type="checkbox"/> OVERHEAD		2		1 of 16'x20'H AND 1 of 12x16 H	
	19	<input type="checkbox"/> ROLL UP		(INSULATED)		SEE DWG & SPEC	
	20	<input checked="" type="checkbox"/> MANUAL GEARED		<input type="checkbox"/> POWERED, VOLTS		PH HZ	
	21	<input type="checkbox"/> SAFETY BAR					
	22	<input checked="" type="checkbox"/> WINDOWS		NO		SIZE	
	23	SEE DWGS AND SPECIFICATION		TYPE		GLAZING	
	24	ALUMINUM		STEEL		OTHER	
CORROSION PROTECTION	25	21		1 of 16'x20'H AND 1 of 12x16 H		SEE DWG & SPEC	
	26	<input checked="" type="checkbox"/> GRAVITY RIDGE VENTILATORS:		<input checked="" type="checkbox"/> CONTINUOUS, THROAT SIZE		24 INCH W/ MANUAL DAMP	
	27	<input type="checkbox"/> WALL LOUVERS:		NO		SIZE	
	28	FIXED		ADJUSTABLE			
	29	<input type="checkbox"/> GUTTERS AND DOWNSPOUTS:		<input checked="" type="checkbox"/> GALVANIZED STEEL		<input type="checkbox"/> ALUMINUM	
	30	<input type="checkbox"/> OTHER		24 GAUGE		SAME MATERIAL AND FINISH AS ROOFING MATERIALS	
	31	<input type="checkbox"/> CANOPIES: SEE DWG FOR SIZE LOCATION					
	32	<input type="checkbox"/> SMOKE CURTAINS: SEE DWG					
	33	EXTERNAL FASTENERS:		<input type="checkbox"/> CADMIUM PLATED		<input type="checkbox"/> STAINLESS STEEL	
	34	<input type="checkbox"/> ALUMINUM		<input checked="" type="checkbox"/> WITH NEOPRENE WASHER		<input type="checkbox"/> COLOR TO MATCH PANELS	
	35	STRUCTURAL BOLTS:		<input type="checkbox"/> MFR STD		<input checked="" type="checkbox"/> GALVANIZED	
	36	OTHER		ASTM A325			
REMARKS	37						
	38						
	39						
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 13295					
<table border="1"><tr><td>BY MB</td><td>APPROVED <i>RJS</i></td><td>ISSUE DATE 8/22/96</td></tr></table>			BY MB	APPROVED <i>RJS</i>	ISSUE DATE 8/22/96	SPECIFICATION FOR LIQUID STORAGE TANKS		
BY MB	APPROVED <i>RJS</i>	ISSUE DATE 8/22/96						
<p>THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.</p> <p>FOR CONVENIENCE, THE NATURE OF THE REVISION IS BRIEFLY NOTED UNDER REMARKS. THESE REMARKS ARE NOT A PART OF THE DOCUMENT. THE REVISED PAGES ARE A PART OF THE DOCUMENT AND SHALL BE COMPLIED WITH IN THEIR ENTIRETY</p>								
REV.	DATE	BY	APPROVAL	PAGES	REMARKS			
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MMR-PLUME RESPONSE PROJECTS						
OTIS ANGB, MA					SPECIFICATION FOR LIQUID STORAGE TANKS	
JEG JOB NO. 35-K-784-00						
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
MB		8/22/96	0	8/22/96		

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 This specification covers the mechanical design, materials, fabrication, and testing of atmospheric and low pressure shop-fabricated welded steel storage tanks.

1.1.2 Tanks are to be fabricated, supplied, and tested, complete with all accessories, in accordance with the tank drawings. In case of conflict, the tank drawings take precedence over this specification.

1.2 RELATED SECTIONS

Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01300	Submittals
Section 09870	Interior Lining System for Steel Storage Tanks
Section 09900	Shop and Field Coating

1.3 REFERENCE STANDARDS (Latest Edition)

1.3.1 Tanks purchased under this specification shall be designed, fabricated, inspected, and tested in accordance with API Standard 650, Welded Steel Tanks for Oil Storage, and applicable appendices, hereafter referred to as API-650, with modifications as outlined in this specification. Appendix J of API-650 shall apply except where more stringent requirements are specified on the drawing or in this specification. The applicable industry standards listed below shall also be considered as part of this specification.

1.3.2 American Petroleum Institute (API)

A.	API Std 650	Welded Steel Tanks for Oil Storage
B.	API Std 2000	Venting Atmospheric and Low Pressure Storage Tanks

1.3.3 American Society of Mechanical Engineers (ASME)

A.	Section VIII Div. 1	Pressure Vessels
B.	Section IX	Welding Qualifications



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SPECIFICATION FOR LIQUID STORAGE TANKS			
1.0 GENERAL (continued)			
1.3.4	ASTM	American Society for Testing and Materials	
1.35	ANSI B16.5	Steel Pipe Flanges and Flange Fittings	
1.4 QUALITY ASSURANCE			
1.4.1	Manufacturer's standard quality assurance/quality control procedures and/or inspection surveillance plan shall apply. A copy of the quality plan shall be available at the fabricator's facility for review by the Owner/Engineer.		
1.4.2	As a minimum, the Owner/Engineer shall be notified at least five (5) business days in advance of any major milestone event (such as plate rolling, long seam welding, hydrotest, etc.) before these activities can start, unless previously agreed otherwise.		
1.5 SUBMITTALS			
1.5.1	All drawings, test reports, and other required documentation shall be submitted to the Owner/Engineer either for approval or for the record in accordance with Jacobs Appendix E, Vendor Data Requirements Form, and with Section 01300 as applicable. Any exceptions taken by the fabricator to the drawings or data requested shall be pointed out in the proposal.		
1.5.2	The purchase order number, tank item number, and tank service description shall appear on each and every vendor drawing.		
1.5.3	As a minimum, the fabricator's drawings shall include the following:		
	A.	Testing procedures used	
	B.	Materials, wall thicknesses, and tank weights	
	C.	Design conditions and corrosion allowances	
	D.	Internal and external coatings and/or linings	
1.6 DEFINITIONS			
1.6.1	"Owner"	Owner or the Owner's Representative	
1.6.2	Engineer	Design Engineer	
1.6.3	Contractor	Manufacturer, fabricator, supplier or subcontractor	



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SPECIFICATION FOR LIQUID STORAGE TANKS			
1.0 GENERAL (continued)			
1.7 PREPARATION FOR SHIPMENT			
1.7.1 The fabricator's standard preparation for shipment of shop fabricated tanks is acceptable with the addition of the requirements listed below.			
1.7.2 All tanks shall be dry, thoroughly cleaned inside and outside, and free of all dirt and loose foreign material.			
1.7.3 All machined surfaces shall be protected with a good grade of rust preventative. All openings shall be covered with appropriate shipping covers. Blinded nozzles and manways shall be shipped with blinds and service gaskets bolted in place.			
1.7.4 Suitable temporary supports, marked and tagged for removal after tank installation, shall be provided to prevent damage during shipment.			
1.7.5 Any tank internals or other appurtenances not installed by the fabricator shall be crated, boxed, and loaded in a manner that will protect all parts from damage or loss in transit and shall be shipped so that they arrive at the erection site prior to or with the tank.			
2.0 PRODUCT			
2.1 MATERIALS			
2.1.1 Materials to be used will be specified on the tank drawing. If these materials are not specified by their ASTM designation, including grade, the vendor shall so specify in his proposal.			
2.1.2 Unless otherwise specified on the tank drawing, the tank fabricator is free to propose any material listed in API-650 suitable for the temperatures and service conditions specified on the drawing, subject to Owner/Engineer approval.			
2.1.3 Structural parts (ladders, platforms, handrails, etc.) shall be hot-dipped galvanized in accordance with ASTM A-123, unless otherwise specified on the tank drawing.			
2.2 DESIGN			
2.2.1 Any specified corrosion allowance shall be added to the tank components as follows:			



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SPECIFICATION FOR LIQUID STORAGE TANKS			
2.0 PRODUCTS (continued)			
A. To the calculated thickness of shell and roof plates.			
B. To the minimum nominal thickness specified for the bottom plates.			
C. To the minimum nominal wall specified for nozzles and manways.			
2.2.2 For operating temperatures above two hundred degrees Fahrenheit (200°F), design shall be in accordance with Appendix M of API-650.			
2.2.3 Loadings from wind, snow, and rainfall shall be in accordance with UBC 1994. Earthquake loading shall be in accordance with API-650, Appendix E.			
2.2.4 Bottom Design			
A. The tank bottom shall be flat with continuous double fillet welded attachment between bottom plates and shell plates, unless otherwise specified.			
B. Where the tank bottom is not fully supported on the foundation, the bottom and any reinforcement of the bottom-to-shell joint shall be designed in accordance with ASME Section VIII Division 1, as applicable. Tank supports shall be designed in accordance with accepted industry practice.			
2.2.5 Shells shall have full penetration double butt welded seams and minimum shell plate thickness as calculated in accordance with API-650.			
2.2.6 Roof Design			
A. Self-supporting roofs for tanks with no internal coating shall have lap welded roof joints with the weld on the top side only.			
B. Self-supporting roofs for tanks with internal coatings shall have either full penetration butt welded seams or lap welded joints with welds on both top and bottom of the roof plates, unless otherwise stated on the drawing. The fabricator shall propose the method of welding which is most economical or feasible in the quotation.			
C. Top angle is required. The joint between the roof plates and the top angle shall be non-frangible.			



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SPECIFICATION FOR LIQUID STORAGE TANKS			
2.0 PRODUCTS (continued)			
2.2.7 Nozzles and Manways			
A. The number, size and service of nozzles and manways will be shown on the tank drawing. Minimum nominal diameter of flanged nozzles shall be 1.5".			
B. The bolt holes on nozzle flanges shall straddle vertical or north-south centerlines, as applicable.			
C. Openings shall not be located in weld seams, and reinforcing pads shall not overlap seams.			
D. Unless specified otherwise, shell nozzles shall have an elevation above the bottom the same as those shown in API-650 defined as "Regular Type".			
E. Manways and blinded nozzles shall be furnished with covers or blinds, bolting, and gaskets by the fabricator.			
F. Manways with covers heavier than the minimum thicknesses given in API-650 Table 3-3 shall be provided with manway davits.			
2.2.8 Reinforcing pads shall have one fourth inch (1/4") NPT tell-tale holes located at the low point of the pad. If the pad is split, each section shall have one hole.			
2.2.9 When specified, draw off sumps will be provided in accordance with API-650.			
2.2.10 If the joint between the roof plates and the top angle is not frangible, the manufacturer shall check emergency venting requirements in accordance with API Standard 2000, and advise Owner/Engineer what measures should be taken to comply, as required.			
2.2.11 Vent connections or manways located in the center of the roof shall be designed to act as the scaffold cable support. Tanks without such connections shall be provided with an API-650 standard scaffold cable support.			
2.2.12 Gauge hatches, if specified, shall be self-closing and non-sparking with a manual hold down feature.			
2.2.13 If specified on the drawing, a ground level reading, vapor tight, automatic liquid level gauge shall be installed by the tank manufacturer.			



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SPECIFICATION FOR LIQUID STORAGE TANKS

2.0 PRODUCTS (continued)

2.2.14 Ladders, Platforms, and Handrails

- A. Tank vendor shall furnish ladders, platforms, and associated handrails and toe plates as specified on the tank drawing.
- B. If specified on the drawing, a platform of minimum size 30" x 42" shall be installed at the top of the ladder.
- C. Handrails shall extend on either side of the platform and along the perimeter of the roof at least six feet beyond any tank roof work area.
- D. Ladders and platforms shall be attached to the tank by bolted connections to welded support clips. Ladders and platforms shall be trial fit in the shop, match marked, disassembled, and shipped loose with the tank for field installation.

2.2.15 Grounding lugs and lifting lugs shall be provided by tank fabricator.

2.2.16 A nameplate shall be furnished in accordance with API-650, and the tank item number shall be stamped on this nameplate.

3.0 EXECUTION

3.1 PREPARATION

3.1.1 Welding

- A. All welding procedures, welders, and welding operators shall be qualified in accordance with ASME Code, Section IX, as supplemented by API 650.
- B. All welding procedure specifications proposed for use by the fabricator shall be submitted for approval by Owner/Engineer, along with accompanying procedure qualification records and weld map, prior to welding. Owner/Engineer reserves the right to approve welder's performance qualification tests.
- C. The selection of welding process is the responsibility of the fabricator, in accordance with this specification and subject to Owner/Engineer approval.
- D. All exposed clips, gussets, and structural members shall be seal welded to their supporting members.

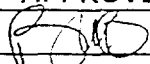
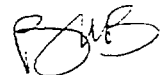


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SPECIFICATION FOR LIQUID STORAGE TANKS			
<p>3.0 EXECUTION (continued)</p> <p>3.1.2 All exposed edges of cut surfaces shall be ground smooth with corners rounded. This includes manway and nozzle necks inside the tank.</p> <p>3.2 INSTALLATION</p> <p>3.2.1 The foundation will be flat concrete mat with anchor bolts. Anchor bolt holes shall straddle north-south centerlines.</p> <p>3.2.2 The foundation will be provided by others. Setting of the finished tank on the foundation will be by others.</p> <p>3.2.3 The underside of the tank bottom shall be shop painted or coated by the fabricator and shall be clean and free of dirt, foreign material, etc. prior to erection.</p> <p>3.3 QUALITY CONTROL</p> <p>3.3.1 Tanks shall be subject to examination, inspection, and testing as required by the referenced API standards and Owner/Engineer's requirements as shown on the tank drawing. A full hydrostatic test is required unless otherwise specified. The Owner/Engineer may also check any plates for thickness or for laminations.</p> <p>3.3.2 The Owner/Engineer or his representative shall have access to inspect the tank construction and witness all testing. Inspection or waiver of inspection shall not relieve the fabricator from full compliance with the specifications and the referenced codes and standards.</p> <p>3.3.3 Shop testing and final inspection, including any necessary repairs, shall take place before the application of any specified coatings or linings.</p> <p>3.3.4 Prior to testing, all welded joints shall be free of scale, splatter, slag, oil, dirt, burrs, and other foreign substances. After the hydrostatic test, the inside of the tank shall be cleaned and free of mud, grit, and water. Where internal linings or coatings are specified, particular care should be taken in preparing internal surfaces suitable for coating per coating manufacturer's instructions.</p> <p>3.3.5 Inspection of welds by sectioning or plugging is not permitted.</p> <p>3.3.6 Radiography, magnetic particle inspection, liquid penetrant inspection, and air/soap testing as specified in the documents shall be in accordance with API-650 and accepted industry practice.</p> <p>3.3.7 When testing welds attaching large reinforcing pads on thin walls, the tank fabricator shall control test pressure to prevent distortion of the tank shell.</p>			



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 13400		
			SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS		
BY WLB	APPROVED 	ISSUE DATE 9/23/96			
THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.					
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REV.	DATE	BY	APPROVAL	PAGES	REMARKS
0	9/23/96	OE		ALL	Issued for Purchase



AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 13400	PAGE 1 OF 18
BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS	
OE	<i>[Signature]</i>	9/23/96	0	9/23/96		

1.0 GENERAL

1.1 PURPOSE

The purpose of this specification is to define the minimum acceptable requirements for the control system for the Extraction Wells and Reinjection Wells associated with the MMR- Plume Response Projects. Vendor is requested to supply the complete Control System through it's organization and clearly state which components that will not be furnished. Provide company name and address for any sub-vendors proposed.

This includes the Control System, Personal Computers and software to monitor and control the overall operation of this project to meet the requirements established on the P&ID's, Instrument Index, Instrument data sheets, and applicable Federal, State and local codes and standards.

1.2 DESCRIPTION

This Specification covers the requirements for labor, materials, and services necessary to the manufacture, test and deliver a real time control system as specified herein. The PLC shall include Process I/O assemblies at the remote sites, the Control Module at the Treatment Plant Control Room, a personal computer based man-machine interface (MMI), an alarm printer, a system printer, uninterruptible power supply, a communication network as required, and all other equipment and appurtenances required for a complete and operable system.

1.2.1 Vendor's Responsibility

- A. System hardware
- B. System software
- C. Capability to communicate with remote I/O assemblies, "Man-Machine Interface (MMI)" and other PLC's utilized in the treatment processes.
- D. System checkout at the jobsite including labor and materials.
- E. System as-built documentation
- F. Uninterruptible Power Supply (UPS)



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

1.0 GENERAL (continued)

G. Recommendation of spare parts

H. Test equipment required for shop and site acceptance test

I. All hardware and software required to guarantee communication performance and protect against electrical interference.

1.2.2 Work not included

A. Installation

B. Field wiring

C. System configuration

D. Communication Network

1.2.3 These projects consist of two of several identified plumes in the existing groundwater that requires remediation. A set of extraction wells installed will be utilized to contain the growth of the plume. Flow from each well will be on flow control with the use of magnetic flow meters and electrical / electronic control valves. The monitoring of the water level in each well shall utilize ultrasonic or capacitance technology. The discharge of each well pump will go into a common double walled header back to a treatment facility.

The treatment facilities will consist of packaged processes where the instrumentation will be provided by the process vendor. There will be some flow, level and pressure instruments as designated on the P&ID's that are not part of equipment vendors scope. A subcontract will be issued for the EPC work in the treatment facilities and not part of this specification.

The water, after treating, will collect in an effluent tank. The water will then be pumped through a header system to a series of reinjection wells. Again, magnetic flow meters with a control valve will control the flow back into the well. Water level will also be monitored.

The attached P&ID's will provide the basis for the inquiry and evaluation of the supplier's bid. The exact type and count will be provided at the time of issuing a purchase order to the successful supplier.



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

1.0 GENERAL (continued)

The process controls will be a PC based system utilizing PLC as the control equipment. I/O will be remote by being installed at each MCC Building and communicating to the central processor in the treatment unit's control room. Local control plan is to have the capability of using a lap top PC at the MCC buildings. Data Hiway will utilize fiber optic cable between MCC Building and Central Control Room. The system will have the capability of data logging, retaining system data in memory, even with the loss of power and the capability of remote alerting on detection of problems. Each project will have it's own control system but have the capability to access data of the other project. Security of accessing data will be built into the overall system software. Jacob Engineering will be responsible for the programming and configuration of the PLC system.

1.3 RELATED SECTIONS

Section 01300	Submittals
Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01600	Materials and Equipment

1.4 REFERENCE STANDARDS (LATEST EDITION)

All work of this section shall comply with applicable portions of the following codes and standards:

- A. American National Standards Institute (ANSI)
- B. Electronic Industries Association (EIA)
- C. Instrument Society of America (ISA)
- D. Institute of Electrical & Electronic Engineers (IEEE)
- E. National Electrical Code (NEC)
- F. National Electrical Manufacturers Association (NEMA)
- G. National Fire Protection Association (NFPA)
- H. Scientific Apparatus Makers Association (SAMA)
- I. Underwriters Laboratories (UL)



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

1.0 GENERAL (continued)

1.5 QUALITY ASSURANCE

The accuracy of each instrumentation system or loop shall be determined as a probable maximum error; this shall be the square root of the sum of the squares of certified "accuracy's" of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of ± 0.5 percent of full scale and a minimum repeatability of ± 0.25 percent of full scale unless otherwise specified. Instruments which do not meet or exceed these criteria are not acceptable.

1.6 SUBMITTALS

All submittals shall be in accordance with the attached Appendix "E" and Section No. 01300, Submittals.

1.7 WARRANTIES

All equipment and systems shall be provided with warranties for a minimum period of one (1) year. Warranty period shall commence on the date of owners acceptance.

Field services shall be performed within 5 calendar days after notification by the Project Manager.

1.8 DELIVERY, STORAGE AND HANDLING

All equipment delivered and placed in storage shall be stored with protection from weather, humidity and temperature variations, dirt and dust or other contaminants. Storage and handling efforts shall ensure the protection of the equipment from mechanical damage.

Vendor shall be responsible for preparation of the equipment for shipment to the system integrator/jobsite. Shipping procedures shall be as specified in Standard Provisions.

2.0 PRODUCTS

2.1 ENVIRONMENTAL CONDITIONS

2.1.1 Equipment and materials shall be suitable for indoor/outdoor service under the plant site conditions. Equipment sensitive to dust and moisture shall be enclosed in a manner that provides maximum protection from airborne dust and moisture.



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

2.1.2 Treatment plant remote operations controller and remote I/O will be installed in Purchaser's ventilated air conditioned/heated control room. As a minimum, the equipment shall be designed to operate under the following conditions:

- A. Temperature Range: Zero to 40 degrees C.
- B. Relative Humidity: 95 percent (non-condensing).

2.2 REMOTE INPUT/OUTPUT MODULES (I/O)

2.2.1 General Requirements

Remote operations controller shall be Manufacturer's standard design and suitable to meet the requirements noted herein. Features shall include:

- A. Modularization: The remote I/O, communication interfaces, and power supplies shall be designed and constructed in a modular manner for ease of module removal or replacement. A positive means of securing the module in place shall be provided to assure proper circuit connection and rigidity during operation. Modules shall be removable under power without damage to the card or the electronics. Overall design shall be such that the modules required for system expansion can be added to provide additional capacity and new functions.
- B. Connection Between Units: All connections between Master Processor, I/O modules, I/O power supply and programming equipment shall be of industrial duty plug connectors which can be easily disconnected. In addition, they shall be keyed and of different plug types to protect against improper connection.
- C. Power Supply
 - Remote operations controller shall be suitable for operation on unregulated electric power at 120 VAC plus 10 percent, 60 hertz plus five percent. If regulation, isolation or other voltage levels are required for proper operation, devices to accomplish this function shall be provided within the unit (System will have backup power).
 - Indicating LED shall be provided to indicate the operating status of the supply unit.



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS	
2.0	PRODUCTS (continued)
	<ul style="list-style-type: none">• Vendor to advise power supply and system grounding requirements.
2.2.2	Input/Output Modules
A.	General
	<ul style="list-style-type: none">• Modules shall be rack-mounted in either, the central control panel or NEMA 12 cabinets. Normal operation shall be achieved without forced ventilation. Enclosures shall be sized to allow the capability of modular expansion.• Analog and discrete input modules shall be mounted adjacent to one another in rows. Wireways shall be supplied inside the enclosure. Terminal points shall be mounted in the same enclosure.• Analog and discrete output modules shall be mounted adjacent to one another in rows in the rest of the enclosure described above for input modules. Other enclosure features listed above for input modules shall be applicable for output modules.
B.	Analog and Discrete Inputs
	Inputs shall have the following features:
	<ul style="list-style-type: none">• Optical isolation of 1600 RMS volts between power and logic signals.• An integral "LED" light indicating the status of field input.• Heavy-duty, 600 volt screw terminal points.• Suitable for rack mounting.• Operable from different voltages:
	MCC Inputs - 120 VAC 60 hertz
	Field Instruments - 120 VAC 60 hertz power supply
	Start/Stop - 120 VAC 60 hertz
	Selector Switch - 24 V DC



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

Field Instruments - 4-20mA or 1-5 V DC

Piping & Instrument Diagram (P&ID's)

[See for quantities of each]. Vendor shall add 20 percent for spares and round up to nearest Manufacturer's grouping.

- Input modules shall be plug-in type, replaceable without disturbing any hard wiring, vibration resistant and locked into position with screws or similar means.
- A termination section for wiring external I/O shall be provided, to which the I/O modules shall be prewired.
- Each terminal block shall be capable of accommodating a minimum of two No. 16 wires on each side. Minimum terminal width shall be 3/8-inch and the minimum clearance between terminal block strips shall be 5-inches. Terminal identification shall incorporate Purchaser's wire numbers.
- A terminal strip shall be provided for customer cable termination for marshaling of vendor wiring.
- Front panels which contain labeling fields for identifying Purchaser inputs with applicable tag number and/or name shall be provided.

C. Analog and Discrete Outputs

Outputs shall have the following features:

- Optical isolation of 1600 RMS volts between power and logic signals.
- Protection from transient voltage surge.
- Heavy-duty, 600 volt terminal points.
- Suitable for rack mounting.
- Operable from different voltages:

MCC Outputs - 120 VAC 60 hertz

Annunciator - 24 V DC



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

Field Instruments - 120 VAC 60 hertz power supply

Field Instruments - 4-20mA or 1-5 V DC

[See attached P&ID's for quantities of each]. Vendor shall add 20 percent for spares and round up to nearest Manufacturer's grouping.

- D. Relay contact (or solid state relay) shall be 3 amp, 120 VAC rating minimum. Output contacts shall be rated not less than 0.8A continuous and 3A inrush with all contacts in the module turned on.
- E. Modules shall be fused for overload and short-circuit protection with blown fuse indication.
- F. "LED" light indicating the status of the discrete output.
- G. Output modules shall be plug-in type, replaceable without disturbing any hard wiring, vibration resistant, locked into position with screws or similar means.
- H. A termination section for wiring external outputs shall be provided. Output modules shall be prewired.
- I. Each terminal block shall be capable of accommodating a minimum of two No. 16 wires on each side. Minimum terminal width shall be 3/8 inch and minimum clearance between terminal blocks shall be 5-inches. Terminal identification shall incorporate Purchaser's wire numbers.
- J. Front panels which contain labeling fields for identifying Purchaser's outputs with applicable tag number and/or name shall be provided.

2.2.3 Communication Interface

- A. Remote operation controller modules shall be rack-mounted and shall communicate:
 - Among themselves
 - With the MMI
 - With microprocessor-based remote operations controllers



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

B. The types of interfaces shall be:

Network Interface: Microprocessor-based modules shall be used to interconnect the remote operations controller (ROC), the personal computer (MMI), the microprocessor-based remote operations controllers (Field Mounted) into a network. These modules will use standard interface protocols to transmit the data between all devices. Data transmission rate shall be suitable for the application plus 20 percent contingency minimum.

2.2.4 Power Supplies

A. Power supply modules shall be rack-mounted and generate the voltages required for the remote operations controller components. Each power supply shall be fused and have short circuit and open circuit protection.

B. Lithium battery backup shall be provided for the volatile memory in the processor and the communications processors.

C. Software shall be licensed as appropriate for Purchaser's use and include the following:

- Function sequence tables (FST)
- C programming
- Skip instructions
- Data manipulation instructions
- Arithmetic, logical, comparisons and move instructions
- Multi tasking
- Hardware priority interrupt handler
- Data highway handler (from various microprocessor based controllers)
- Diagnostics
- Power failure protection
- Data transfer and block transfer



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

- D. Diagnostics: Hardware and operating programs will be monitored to provide timely detection of problems or other potential interruptions. Data on type and location of faults as well as system programming information will be displayed in tables which are accessible to the CRT programmers' terminal (the microcomputer operation stations). Vendor shall advise the level of troubleshooting capabilities available with his programs and frequency checks are performed.
- E. Power Failure Protection: The remote operations controller shall shutdown in an orderly fashion in the event of a power failure or major power transient. The stored memory shall be protected for a minimum of 72 hours in case of power failure [Uninterruptible Power Supply (UPS) will be provided and supplied by others].

2.2.6 Programming Software (MMI/Laptop Computer)

- A. Vendor shall specify the number of function blocks of program which can be displayed at one time.
- B. Program monitoring, editing and changes shall be made off-line or on-line from the programmer (laptop computer).
- C. The keyboard shall provide for all programming elements and the CRT shall give a visual display of each function sequence block and/or "C" programming.
- D. The program panel shall have the capability to monitor/program (using a laptop computer).
- E. One 1.4 MB 3 1/2 inch drive for uploading, downloading the program.

2.2.7 Field Cabinets

Vendor shall furnish cabinet(s) (NEMA 12) for housing the remote mounted hardware associated with the well mounted I/O for each MCC building (3 ea for FS-12 and 1 ea. For SD-5), and one cabinet for the central control room for housing the treatment plant CPU and I/O modules. The Control Room cabinet shall be of NEMA 12, double door and/or single door construction.

2.3 PROGRAMMABLE LOGIC CONTROLLER (PLC)



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

2.3.1 General Requirements

- A. The PLC shall be a panel-mounted microprocessor-based remote operations controller. The PLC's PC shall indicate the process variable, setpoint and controller output. All operating adjustments (set point, auto/manual transfer switch, manual output, setpoint selector) shall be clearly identified on the Graphic screen. The I/O shall accept isolated 4-20 mA DC current or 1-5 VDC voltage inputs and provide 120 VAC/24 VDC digital input and output as shown on block diagram. Input signal sampling rate shall be 0.1 second or better. Supply voltage shall be 120 VAC, frequency 60 hertz.
- B. Processor memories shall be sized to provide the total project process/instrumentation and control requirement plus 20 percent spare capabilities.
- C. In no case, however, shall the memory size be less than 12,000 words (16 bit word length). Memory shall be RAM, PROM, or combinations thereof. Vendor shall state the size in word capacities of each type of memory proposed and a memory map designating the work capacities in the following areas:
- Function sequence tables (FST)
 - Data memory for users stored program data
 - I/O status memory
 - Executive program
 - PC operational programs
- D. The processor shall include the following:
- A key-operated mode select switch/password protection shall be provided on the processor door to select processor operating modes, including program load, run and test positions. In program load mode, the outputs shall be disabled to allow programming. In the test mode, the outputs shall be disabled but the program will be operating to allow monitoring of the program. In the run mode, normal operation shall occur with outputs enabled and program running. Provisions to allow "on line programming" shall be provided through the laptop computer.



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS			
2.0 PRODUCTS (continued)			
<ul style="list-style-type: none">• A fault monitor shall be provided on the door of the processor to indicate processor and I/O faults. Should an I/O module fault occur, the monitor shall indicate the location of the fault. As an option, the MMI may be used to indicate fault locations.• Status indicators shall be provided to indicate the run status of the processor and the status of the outputs (whether enabled or disabled). In addition, there shall be visual indication that the processor is in the program load mode.• Processor modules shall be keyed to guard against incorrect insertion. Processors shall be rack mounted.• Status indicators shall be provided on the visible front edge of the processor modules to provide status information (including the status of the batteries).			
2.3.2 Control Features			
<p>The non-volatile memory of the PLC shall be configurable from a laptop computer. For security the entry functions shall be lockable, allowing anyone to review configured parameters but preventing unauthorized changes. Programmable control strategies shall include as a minimum:</p>			
<ul style="list-style-type: none">A. PID for feedback, cascade and feedforwardB. RatioC. Non-linear signal characterizerD. Error squaredE. External resetF. Input bias gainG. Output biasH. Addition, subtraction, multiplication, division, square rootI. Dead time			



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS			
2.0 PRODUCTS (continued)			
2.3.3 Alarms			
The controller shall have independently adjustable deviation and process variable level alarms. These alarms shall be configurable and provide visual indication on the controller face upon an alarm condition.			
2.3.4 Communications			
The controllers shall be linked together for exchange of information with the treatment plant PLC processor and/or the MMI. The link shall communicate at the manufacturer's standard +20 percent counting rate (copper only).			
2.3.5 Diagnostics			
The controller shall perform continuous on-line tests. Manual control of the controlled output will be placed in operation if an error is detected during on-line configuration.			
2.3.6 Power Failure			
In failure mode, controller shall retain last set point as well as control strategies.			
2.4 MAN-MACHINE INTERFACE SYSTEM (MMI) (Microcomputer Operator Stations)			
2.4.1 General Requirements			
Microcomputer operator stations shall be minimum 486DX33 industrialized personal computers. Operator station shall have the capability to on-line display any of the data resident in the remote operations controller or the microprocessor based single loop controllers (Field Mounted) and enter commands to any of these units. In the off-line mode, these stations shall be capable of system development, data analysis and operator instruction.			
A. Operator station shall have a configurable scan cycle of between 1-5 seconds and be capable of handling a minimum of 1,000 active points. Tag lengths and associated identifiers shall be a minimum of 9 character spaces each.			
B. The operator stations will be housed in an air-conditioned/heated control room.			
Minimum of a 19-inch high resolution (640 x 480 pixels) color VGA Monitor.			



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS			
2.0 PRODUCTS (continued)			
Minimum of an 8 Mb RAM w/clock and calendar card and 2 MB extended memory for graphics.			
One minimum 250 MB hard disk drive.			
One 3 1/2 inch diameter 1.44 MB capacity floppy disk drive:			
<ul style="list-style-type: none">• Recording user's program on floppy disk.• Loading a user's program from a floppy disk ("ROC" and "MMI" programs)			
Communication cards for interfacing with remote operations controller and field mounted microprocessor based controllers through data highway.			
Monitor color adapter card, color graphics card to support a minimum 16 colors.			
Mouse for graphic generation (one required).			
C. One color and one black and white printer, each with buffer memory shall be provided for CRT screen printing, logging and alarming. Normally each printer shall only perform one of these tasks. However, upon failure, the other printer shall be capable to perform both functions. Printers requirements are:			
Alarm Printer			
An alarm shall be supplied to print alarms generated by the man-machine interface system. It shall be a parallel printer with a 15 inch cartridge, tractor feed, draft and letter quality modes, and a 27 pin dot matrix type printhead. It shall have a speed of 150 cps or greater in draft mode. It shall have the capability to print function sequence table listings or configuration generated by the programming/configuration software and alarm logs generated by the MMI System software specified herein.			
Report Printer			
A color printer shall be supplied to print hard copies of MMI system displays and periodic reports. The printer shall be a color, liquid jet type printer capable of printing MMI displays on demand at a rate of no more than 4 minutes per page. Black print speed shall be at least three pages per minute. Paper size shall be 8 1/2 x 11 inches or larger. Resolution shall be 300 dots per inch. The printer shall be capable of printing on overhead transparency film or specialty coated paper.			



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS			
2.0 PRODUCTS (continued)			
2.4.2 Software			
A. General Requirements			
<p>Software shall be supplied which utilizes the CRT, disk and printer resources of the personal computer. The operating system software and/or firmware shall support the following functions:</p>			
<ul style="list-style-type: none">• Data acquisition and creation• Data display and history• Data printing• Peripheral interface handler• Multi-tasking• Diagnostics• File management• Hardware priority interrupt• Interface w/programmable controllers• Screen dump to dedicated graphic printer			
<p>Real time programs which interact with data received via the communications link shall be provided to allow the user to develop custom control strategies, graphic displays, logs, etc. In addition, personal computer application programs such as MS DOS 5.0 or higher shall be provided.</p>			
<p>Software licenses shall be included as appropriate for purchasers use of software.</p>			
B. Graphic Building and Display			
<p>Graphics depicting real time process data or status, operator messages and alarms, animated presentations and graphic displays shall be generated through the graphics building package and used on-line by the operator to interface with the process. A minimum of 10 graphic displays will be built by the Vendor using a menu driven procedure with a mouse cursor positioning</p>			



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

device. This procedure shall allow the user to generate symbols, lines, etc. using standard character sets in a variety of colors and line widths. (A minimum of 16 foreground and 16 background colors shall be provided with the programs. Display of these colors may be either in a solid or hatched format.) The procedure shall incorporate a rubber band feature which will allow the user to create the desired shape and size of the object before it is permanently placed on the screen. Other functions such as repainting, moving, copying, erasing and rotating shall be included to allow the user to edit the displays. Active analog and digital points and links to other displays will be included on the displays. The analog values may be expressed as a number, bar graph or a trend. The digital values will be used to tie symbols or messages to its status. The program shall allow a minimum of 64 active points per graphic page. Each graphic display shall contain soft keys which will provide links to other displays.

C. Data Logging

Process variables and production quantities in engineering units shall be automatically reported to the operator on one printer at 8 and 24 hour intervals. The log program shall allow the user to specify the points to be processed as either the average, maximum, minimum, last value or total of the data scanned in each hour of the shift or day. The log report shall be printed in a tabulated format with user defined title and active point description. Each report format shall be able to contain at least 30 active points. Up to 20 different logs will be configurable.

D. Trending

Both real time and historical trending capabilities shall be provided. Each trend shall contain a minimum of 4 points (in different colors), be selectable and be trended simultaneously. The sampling time base shall be adjustable and range from 1 minute to 48 hours.

Historically trending data shall be collected, processed and stored for a period of 72 hours for all analog points. The user shall be able to configure the historical data to be stored in daily, weekly, or monthly files. For record purposes and further management analysis, the historical data shall be convertible to files compatible for Lotus 1-2-3, Excel, etc.



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS			
2.0 PRODUCTS (continued)			
E. Overview, Group and Point Displays			
<p>These displays shall be pre-formatted and require only fill-in-the blanks configuration by the user to implement. The display shall contain targets which will allow the operator to quickly index any of the detail displays from a higher level display or vice versa.</p> <p>The overview will summarize the general status and alarm of all the active points in the groups. Overview displays each with ten groups per page shall be provided as required.</p> <p>Group displays shall contain a minimum of 6 points per group. The points in these groups will be arranged by the user to suit the process. This means critical points may be contained in several groups. A minimum of 30 groups shall be configurable. Controller and status point templates shall be available for the user to build the group displays. The controller template will be used for open/close, start/stop or PID control functions, and will contain at least two bar graphs (normally process variable and setpoint); digital value of setpoint; number and loop status. Status displays will be used to stop and start or open and close the various motors and to display their condition.</p> <p>Point displays retain the information on the templates plus the configurable point details (standard control features implemented in the microprocessor-based controller).</p>			
F. Alarming			
<p>Whenever an alarm occurs anywhere in the system, the operator's attention shall be directed to the current display by flashing of the point and/or a message on the screen. The alarm message shall also appear on the alarm summary display and be stored for printout when demanded by Management.</p> <p>Once an alarm occurs, the alarm indicator shall be maintained until the alarm is acknowledged, even if the alarm point has returned to normal.</p> <p>Alarm disable and enable capability shall be provided.</p>			



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SPECIFICATION FOR CONTROL SYSTEM GENERAL REQUIREMENTS

2.0 PRODUCTS (continued)

G. Communications

A communications program will send or receive analog, digital and totalizer data between the MMI and the remote operations controller.

Transfer rate of this data shall be such that operator initiated changes will be verified on the screen in 5 seconds (maximum).

H. Diagnostics: Diagnostic programs shall be provided which display error and status information, thereby allowing for a maintenance and problem solving. A memory checking routine shall be provided to prevent erroneous operation if an error is detected in program execution.

2.5 AUTOMATIC DIALING ALARM MONITOR

The monitor shall be a microprocessor based system that shall sense four alarm conditions at the site. In addition, power failure shall be sensed internally and shall not require using one (1) of the fault channels. Upon detection of any of the fault conditions or power failure, the unit shall commence dialing the first of eight (8) user selected phone numbers and deliver a message describing the actual alarm condition. This message shall be delivered in an electronic digitized voice, utilizing the user's own digitally recorded voice. Message programming shall be accomplished by speaking into the system and shall not be limited to internal synthesized speech vocabulary. Messages will include actual system location and alarm conditions. The unit will continue to call the phone numbers in succession until acknowledged by calling the unit back or by depressing a touch-tone key. Once acknowledged, the unit shall enter a programmable intercall delay to allow the alarm condition to be attended to before beginning notification again. Additionally, the system shall have the capability of answering incoming calls. Upon receipt of a call, the system shall report the station status to the caller. All communications shall utilize telephone lines; no leased or dedicated lines shall be required.

3.0 EXECUTION

NOT USED

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Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00				NO. 13411	
				SPECIFICATION FOR FLOW CONTROL VALVES	
BY	APPROVED	ISSUE DATE			
OE	<i>[Signature]</i>	8/19/96			
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 13411	PAGE 1 OF 3
					SPECIFICATION FOR FLOW CONTROL VALVES	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
OE	<i>[Signature]</i>	8/19/96	0	8/19/96		

1.0 GENERAL

1.1 SCOPE

The Vendor shall furnish all control valves, complete and operable as indicated and specified herein, in accordance with the requirements of the Contract Documents.

1.2 RELATED SECTIONS

Section 13431 - Electric Motor Valve Operators

1.3 REFERENCES

The following standards and practices are considered an integral part of this specification:

ANSI B16.5	Steel Pipe Flanges and Flanged Fittings
ANSI B16.104-1976	Seat Leakage Classifications
ANSI S1.13-1971	Methods of Measurement of Sound Levels

1.4 SUBMITTALS

A. Refer to Appendix E for submittal requirements.

B. Shop drawings of all valves and operators including associated wiring diagrams and electrical data.

C. Control valve sizing and predicted noise calculations.

D. Submittals shall be made in accordance with Section 01300, "Submittals".

1.5 QUALITY ASSURANCE

A. Testing

Each valve shall be fully assembled in the shop prior to testing. Each valve shall be test stroked with a 4-20mA input signal.

Each set of valves seats shall also be tested for leakage.



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SPECIFICATION FOR FLOW CONTROL VALVES

1.0 GENERAL (continued)

After complete assembly, each valve shall be opened and closed at least three times. Each complete valve and control assembly shall be operated as a unit.

1.6 WARRANTIES

All equipment and installation shall be provided with warranties for a period of one (1) year minimum. Warranty period shall commence on the date of owners acceptance.

2.0 PRODUCTS

2.1 GENERAL

A. The control valves shall be electric operated ball type or butterfly body design as indicated elsewhere. The valve shall be top guided with equal percentage trim. Control valves shall be provided with stem travel indicators and shall be bolted bonnet type.

B. Control valve sizing shall include calculation for predicted noise generation. Valve noise should be designed with a maximum noise level of 80 dBA at 3 feet during operation at full load.

C. The electrical operators shall be furnished by the valve manufacturer as a complete package together with the valve and all necessary connection's.

D. Ball pattern valves shall have carbon steel body with flanged ends conforming with ANSI class 150 for valves 1-inch and larger. All interior passages in contact with water, shall be epoxy-coated. The valve trim shall be of stainless steel.

E. Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Subcontractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.



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SPECIFICATION FOR FLOW CONTROL VALVES

2.0 PRODUCTS (continued)

F. Butterfly valves shall conform to API STD 609, ANSI class 150, wafer or Lug design, as indicated, cast carbon steel body per ASTM A216 Grade WCB, carbon steel disc, trunion mounted, 17-4 PH H1025 stem, 316 SS bearings, Teflon® seal and backing ring, Teflon® /V-type packing. Valve shall be compatible with ANSI raised faced pipeline flanges.

3.0 EXECUTION

(Not Used.)



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MMR-PLUME RESPONSE PROJECTS

OTIS ANGB, MA

JEG JOB NO. 35-K-784-00

NO. 13412

SPECIFICATION FOR
PRESSURE GAGES

BY	APPROVED	ISSUE DATE
OE		8/19/96

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8/19/96

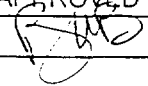
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 13412	PAGE 1 OF 2
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OE		8/19/96	0	8/19/96		

1.0 GENERAL

1.1 GENERAL REQUIREMENTS

Provide pressure gages as specified, complete, including all fittings, connections, gasket, supports and accessories in the locations shown or specified in accordance with the requirements of the Contract Documents. Ranges will be selected to place the normal operating pressure between 40 and 75% of full scale.

1.2 SUBMITTALS

A. Refer to Appendix-E for submittal requirements.

B. Refer to additional requirements sheet for miscellaneous items.

C. Submittals shall be made in accordance with Section 01300, "Submittals".

1.3 QUALITY ASSURANCE

The gages shall be made in accordance with ANSI B40.1, Accuracy Grade 2 A.

2.0 PRODUCTS

2.1 GENERAL

Pressure gages shall be provided on suction and discharge connections of pumps; on discharge connections of blowers and compressors; each side of pressure reducing valves; and where shown. In all locations where pressures may vary from below to above atmospheric head, compound gages shall be installed.

2.2 GAGE CONSTRUCTION

Pressure gages shall be bourdon tube type, with stainless steel bourdon tubes and movements and have 4 1/2" round dials with white plastic faces. Solid front metal case gages with rear blowout disc.



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SPECIFICATION FOR PRESSURE GAGES

3.0 EXECUTION

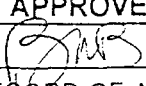

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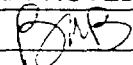


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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00				NO. 13413	
				SPECIFICATION FOR MAGNETIC FLOW METERS	
BY OE	APPROVED 	ISSUE DATE 8/19/96			
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 13413	PAGE 1 OF 2
					SPECIFICATION FOR MAGNETIC FLOW METERS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
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1.0 GENERAL

1.1 GENERAL REQUIREMENTS

Furnish magnetic flow meters and all appurtenant work suitable for the service indicated. Magnetic flow meter shall be capable of continuous operation with minimum error due to mineral deposits that may build up on the sensing element, and shall be in accordance with the requirements of the Contract Documents.

1.2 SUBMITTALS

A. Refer to Appendix-E for submittal requirements.

B. Refer to additional requirements sheet for miscellaneous items.

C. Submit meter sizing calculations for each meter.

D. Submittals shall be made in accordance with Section 01300, "Submittals".

1.3 QUALITY ASSURANCE

After installation, the Subcontractor shall obtain the services of an experienced factory service representative to inspect and test all meters for proper performance and installation. Unless otherwise specified herein, the flow meters shall be guaranteed to register flow to an accuracy of ± 2 percent of actual flow throughout the calibrated range.

1.4 WARRANTIES

A. All equipment and installation shall be provided with warranties for a period of one (1) year. Warranty period shall commence on the date of owners acceptance.

B. Services shall be performed within 5 calendar days after notification by the Contractor.



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SPECIFICATION FOR MAGNETIC FLOW METERS

2.0 PRODUCTS

2.1 GENERAL

The magnetic flow meter shall utilize characterized electromagnetic induction to produce a voltage linearly proportional to the average flow rate. The metering system shall consist of a sensor with field coils, transmitter and interconnecting cables to make a complete operating flow metering system. The meter shall be of the bi-polar pulse dc type with continuous automatic zeroing. The meter shall automatically compensate for temperature and aging drift. The meter shall require no zero adjustment. The meter full-scale velocity shall be 1-33 feet per second, with rangeability of 33:1. The meter shall require not more than 5 micromhos per centimeter conductivity.

2.2 BASIC MATERIALS

The sensor shall be a flanged tube with non-conductive liner. The tube shall be constructed of Type 304 stainless steel with carbon steel flanges. Sensor rating shall be either NEMA-4x or capable of withstanding accidental submergence in water to a depth of 30 feet for 48 hours. The meter shall include a positive zero feature for periods when the metering portion of the process pipe has no flow. The power supply shall be 120 volts, single-phase, 60 Hz. Power demand shall not exceed 10 VA with AC power regardless of size. Liner material shall be polyurethane or Teflon. External surfaces shall be factory finished with a corrosion resistant coating.

2.3 GROUNDING

Grounding rings of the same material as the sensing electrodes shall be furnished mounted in each end of the meters.

2.4 TRANSMITTER

The transmitter may be either integrally mounted or remote mounted. If the transmitter is remote mounted, the interconnecting cable shall be furnished by the manufacturer of the metering system. Remote transmitter shall be housed in NEMA-4X enclosures suitable for wall mounting. The transmitter shall be 120 VAC powered and produce an isolated 4-20 mA dc output signal. It shall have a built-in totalizer feature that displays the total flow upon command.

3.0 EXECUTION

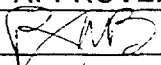

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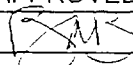


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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 13421		
			SPECIFICATION FOR LEVEL TRANSMITTERS (ULTRASONIC TYPE)		
BY OE	APPROVED 	ISSUE DATE 8/19/96			
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 13421	PAGE 1 OF 1
					SPECIFICATION FOR LEVEL TRANSMITTERS (ULTRASONIC TYPE)	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
OE		8/19/96	0	8/19/96		
1.0 GENERAL						
1.1 GENERAL REQUIREMENTS						
The Contractor shall furnish Ultrasonic Type Level Transmitters, complete and operable as indicated and specified herein in accordance with the requirements of the Contract Documents.						
1.2 SUBMITTALS						
A. Refer to Appendix E for submittal requirements.						
B. Refer additional requirements form for miscellaneous items.						
C. Submittals shall be made in accordance with Section 01300, "Submittals".						
2.0 PRODUCTS						
2.1 Ultrasonic flow measuring systems shall consist of an electronic transmitter, a non-contact sonic transducer, and interconnecting cables. The transmitter shall have solid state design, NEMA 4X enclosure, isolated 4-20MA output signal linearly proportional to level, and transducer temperature compensation. The transmitter shall provide 3 contact outputs (field adjustable) for alarm or logic function. The unit shall provide fault relay de-energize on echo lost/system fault/level alarm.						
2.2 The sonic transducer shall be watertight and constructed of corrosion resistant materials. The transducer assembly shall be suitable for hazardous locations and have FM approval.						
3.0 EXECUTION						
(Not Used.)						



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OTIS ANGB, MA
JEG JOB NO. 35-K-784-00

NO. 13422

SPECIFICATION FOR
PRESSURE TRANSMITTERS

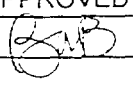
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					SPECIFICATION FOR PRESSURE TRANSMITTERS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
OE		8/19/96	0	8/19/96		
1.0 GENERAL						
1.1 GENERAL REQUIREMENTS						
Furnish pressure transmitters, complete and operable as indicated and specified herein in accordance with the requirements of the Contract Documents.						
1.2 SUBMITTALS						
A. Refer to Appendix E for submittal requirement.						
B. Refer additional requirements form for miscellaneous items.						
C. Submittals shall be made in accord with Section 01300, "Submittals".						
2.0 PRODUCTS						
2.1 Pressure transmitter shall be a 2-wire transmitter, have field adjustable span, and zero, adjustable damping, zero elevation and suppression adjustments, all solid state circuitry in a NEMA 4X enclosure, a bonded strain gage or capacitance type sensing element, all process wetted parts of Type 316 stainless steel, body material of Type 316 stainless steel, an accuracy of ± 0.25 percent of span, 1/2 inch NPT process connection, shall produce a linear 4-20 mA output signal in proportional to differential pressure, shall have a minimum load limitation of 600 ohms at 24 VDC, and shall have a local indicator scaled in engineering units.						
3.0 EXECUTION						
(Not Used.)						

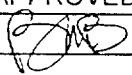


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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00				NO. 13423	
				SPECIFICATION FOR LEAK DETECTION SYSTEM	
BY	APPROVED	ISSUE DATE			
OE		9/19/96			
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BY	APPROVED	ISSUE DATE	REV. NO.	DATE	SPECIFICATION FOR LEAK DETECTION SYSTEM	
OE		9/19/96	0	9/19/96		

1.0 GENERAL

1.1 DESCRIPTION

Furnish and install a complete distributed leak detection system in conjunction with installation of the double wall pipe system. Work shall include the electronic alarm and locator modules (ALMs), aqueous chemical sensing cable, graphic display maps and auxiliary services and equipment as described within this specification. The system shall automatically detect the presence of aqueous liquids (groundwater) in a secondary containment pipe. When an aqueous fluid is detected, the system shall provide an audible and visual alarm at the ALM, a visual alarm at the control room and locate the event on the cable with a digital display at the ALM to within \pm one foot of the liquid at any location along the sensing cable length.

1.2 RELATED SECTIONS

Section 01300	Submittals
Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01600	Materials And Equipment
Section 15060	Double Containment Piping Systems

1.3 REFERENCE STANDARDS (Latest Edition)

All work of this section shall comply with applicable portions of the following codes and standards:

- A. American National Standards Institute (ANSI)
- B. Electronic Industries Association (EIA)
- C. Instrument Society of America (ISA)
- D. Institute of Electrical & Electronic Engineers (IEEE)
- E. National Electrical Code (NEC)
- F. National Electrical Manufacturers Association (NEMA)
- G. National Fire Protection Association (NFPA)



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SPECIFICATION FOR LEAK DETECTION SYSTEM

1.0 GENERAL (continued)

H. Scientific Apparatus Makers Association (SAMA)

I. Underwriters Laboratories (UL)

J. American Society of Testing And Materials (ASTM)

1.4 QUALITY ASSURANCE

The accuracy of each system or loop shall be determined as a probable maximum error. This shall be the square root of the sum of the squares of certified accuracy's of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual component shall have a minimum accuracy of ± 0.5 percent of full scale and a minimum repeatability of ± 0.25 percent of full scale unless otherwise specified. Components which do not meet or exceed these criteria shall not be acceptable.

1.5 SUBMITTALS

All submittals shall be in accordance with the attached Appendix "E" and Section 01300, Submittals.

1.6 WARRANTIES

A. All equipment and systems shall be provided with warranties for a minimum period of one (1) year. Warranty period shall commence on the date of Owners acceptance.

B. Field services shall be performed within 5 calendar days after notification by the Owner/Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

All equipment delivered and placed in storage shall be stored with protection from weather, humidity and temperature variations, dirt and dust or other contaminants. Storage and handling efforts shall ensure the protection of the equipment from mechanical damage.



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SPECIFICATION FOR LEAK DETECTION SYSTEM			
2.0 PRODUCTS			
2.1 GENERAL REQUIREMENTS			
2.1.1 The system shall be a TraceTek 3000 Longline System manufactured by Raychem Corporation. Material and components shall be as specified below, as indicated on the drawings and as required for operation.			
2.1.2 Throughout the specification, types of material and equipment are specified by manufacturers name and catalog number. The Contractor may not assume the phrase "or equal." The Contractor shall not furnish or install any substitute material or equipment without prior approval of the Owner / Engineer.			
2.1.3 To obtain the Owner/Engineer's approval to substitute material or equipment, the following shall be submitted, in accordance with Article 1.5, Submittals.			
A. Reason for substitution.			
B. Complete manufacturers data, sample and installed cost of the specified material or equipment.			
C. Complete manufacturers data, sample and installed cost of the proposed substitute/alternate material or equipment.			
2.1.4 The Subcontractor assumes all risks and costs associated with acceptance or rejection of proposed substitutions/alternates, including redesign and readjustment of all work affected thereby.			
2.2 LEAK DETECTION EQUIPMENT			
2.2.1 Alarm And Locator Modules (Alm's)			
Each ALM shall be a Raychem TraceTek Model TTE. Each ALM shall be capable of monitoring a maximum circuit length of 3000 feet. Circuit length shall include all jumper wires and connectors if such devices count in circuit length displayed by the ALM.			
Each ALM shall provide relays as required for providing local and remote alarms upon loss of sensing cable continuity, leak detection or loss of power. Remote alarms shall be transmitted to the control system's I/O cabinet as indicated on the P&ID's. Alarms shall be initiated by relay contacts closures.			



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SPECIFICATION FOR LEAK DETECTION SYSTEM

2.0 PRODUCTS (continued)

ALM's shall be of physical size suitable for surface mounting. ALM enclosures shall be rated NEMA 4X. Thermostatically-controlled strip heaters shall be provided in enclosures as required to protect module electronics.

ALM's shall operate from a power service at 120 VAC, single phase, 60 Hertz. ALM's shall continuously monitor all sensing and interconnecting cables for continuity and detected leaks. Any break in cables or detected leaks shall result in local audible and visual alarm, and actuate an output relay. Loss of power shall notify the control system of the event.

2.2.2 Portable Test Box

The contractor shall provide two portable test boxes (Raychem TraceTek Model TTM-1KM or approved equal) to permit field testing of the leak detection system.

2.2.3 Sensing Cable

The sensing cable shall detect the presence of aqueous chemical (acids, bases, and groundwater) all along its length. The cable shall be Raychem TraceTek Type 3000. A continuous run of sensing cable shall be installed in the annulus of all double-containment groundwater collection piping at the 6 o'clock position. The cable shall be resistant to corrosion, abrasion, and most chemicals and tested in accordance with exposure procedures in ASTM D-543 (Resistance of Plastics to Chemical Reagents) for seven days or other applicable testing standards.

Sensing cable jacket shall be constructed of fluoropolymer (Kynar) materials or stainless steel. The connectorized sensing cable shall have a pull strength of no less than 80 pounds. The sensing cable shall be capable of accommodating branch connections indicated on the drawings. Branch connectors shall be Raychem TraceTek Type TT-MBC.

2.2.4 Jumper Cable

Jumper cable shall be available as required to interconnect sensing cables. No jumper cable shall be allowed inside the annular space of double-containment piping systems.



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SPECIFICATION FOR LEAK DETECTION SYSTEM			
2.0 PRODUCT (continued)			
2.2.5 Electrical			
A. Control panel electrical work shall conform to the latest National Electrical Code.			
B. Wiring shall be installed in Panduit or equal wireway.			
C. Separate wireway systems shall be installed for the following systems:			
• AC power distribution and Control (120AC).			
• Low voltage signal and alarm (4 to 20 mA DC and 24VDC).			
D. Wireways shall be sized so that at any point in the wireway the total cross-section area of the wire and insulation shall not exceed twenty-five percent (25 percent) of the cross-sectional area of the wireway.			
E. Wireways shall be located so that they will not interfere with the access to any panel mounted instruments or equipment and shall not encroach on space allotted for future instruments.			
F. The wireway design shall always include adequate space and radius to pull future field wiring cables.			
G. Terminal strips shall not be installed in wireways. Splicing shall not be done in wireways.			
H. Wireway shall have a retaining device or bracket to hold wires in wireway.			
I. Individual conductors shall be identified by permanently affixed plastic markers at each end.			
J. Wire termination on any screw-type terminal shall use insulated crimp-on flanged spade or ring tongue type lugs.			
K. Single conductor wiring shall be #14 AWG type THWN-MTW minimum; shielded cable shall be used for 4-20 mA signals and shall be Belden type 9341 or equal, unless indicated otherwise on the drawings. Color coding of wiring shall be in accordance with ANSI/MC96-1 Design Standard.			



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SPECIFICATION FOR LEAK DETECTION SYSTEM

2.0 PRODUCT (continued)

L. All field wiring shall connect to the control panel at a vertical terminal strip. Terminal strips for field wiring shall be supplied for each wireway system and shall be rail mounted in the panel as indicated on the drawings. Twenty (20) percent spare terminals of each type shall be provided.

M. Panel wiring shall be restricted to one side of terminal strips mounted in the panel. The other side shall be left free for field wiring.

N. The panels shall be provided with a 1/4" thick x 1" wide bare soft copper ground bus bar.

2.2.6 Nameplates

A. Each piece of equipment shall be furnished with a single nameplate.

B. Interior nameplates shall be attached to the panel surface with a double-backed adhesive foam tape. Exterior nameplates shall be attached to the panel with corrosion resistant screws.

C. Embossed tape nameplates are not acceptable.

D. Rear-of-panel nameplates shall contain the tag number only. Unless otherwise specified, nameplate legend abbreviations shall conform to ANSI Y1.1, "Abbreviations for use on drawings and in text".

3.0 EXECUTION

3.1 EXAMINATION

The Contractor shall verify site conditions and make all inspections necessary to determine the full extent of the work required to make the completed installation of the leak detection system conform to the Drawings and Specifications. Discrepancies or inaccuracies that may prevent full prosecution of the specified work are to be resolved prior to commencement of the work.

3.2 INSTALLATION

All system material and components shall be installed in accordance with the manufacturer's installation instructions. The contractor shall be responsible for providing a clean and functional system. Supervision and training of Owner personnel shall be provided by the contractor and the manufacturer of the leak detection system. The manufacturer shall provide warranty and correct system deficiencies at no additional cost to the Owner for a period of one year from the date of system acceptance by the Owner.



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SPECIFICATION FOR LEAK DETECTION SYSTEM			
<p>3.0 EXECUTION (continued)</p> <p>3.3 FIELD QUALITY CONTROL</p> <p>A. The Contractor shall use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.</p> <p>B. The Contractor shall use equipment adequate in size, capacity and numbers to accomplish the work of this section in a timely manner.</p> <p>C. In addition to complying with requirements of governmental agencies having jurisdiction, the Contractor shall comply with the directions of the Owner/Engineer.</p> <p>D. After installation of the leak detection system, a final testing shall be performed to ensure the condition of the sensing cable. The sensing cable will be measured with the portable test box and recorded for review and approval of the Owner/Engineer.</p>			



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NO. 13431

SPECIFICATION FOR
ELECTRIC MOTOR VALVE
OPERATORS

BY	APPROVED	ISSUE DATE
OE/WLB		8/19/96

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 13431	PAGE 1 OF 9
					SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
OE	<i>RMB</i>	8/19/96	0	8/19/96		

1.0 GENERAL

1.1 SCOPE

Unless otherwise indicated, all shut off and throttling valves shall be provided with power operators. The Vendor shall furnish and install valve operators, complete and operable, including all controls, motors, gears, etc., as indicated and as specified herein, in accordance with the requirements of the Contract Documents. The Vendor shall coordinate all mechanical, electrical and instrumentation drawings to provide a complete, functional installation.

All operators of a given type shall be furnished by the same manufacturer. Where different types of operators are supplied by different manufacturers, the Vendor shall coordinate their selection to provide uniformity of each type of electric operator. All valve operators, regardless of type, shall be installed, adjusted, and tested by the valve manufacturer at the manufacturing plant.

1.2 RELATED SECTIONS

Section 13411 - Flow Control Valves

1.3 QUALITY ASSURANCE

For all electric motor operators, the Subcontractor shall assign the valve Manufacturer the responsibility of any field adjustments to set the operator limit switches for the required function. The Subcontractor shall include the cost of this service in the bid. All wires of motor operators shall be identified with a unique number.

1.4 SUBMITTALS

1.4.1 The Subcontractor shall submit design calculations showing required closing torques and design torque provided with each operator.

1.4.2 Shop detail drawings for valve operators shall be submitted in accordance with Vendor Drawing and Data Request (VDDR) form.



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS

1.0 GENERAL (continued)

1.4.3 DOCUMENTATION

The following data shall be furnished for on-off motor valves:

A. Motor data including the following

- Rated HP (or KW) and rated torque in foot-pounds.
- Rated speed.
- Rated voltage.
- Full load current at rated voltage.
- Efficiency and power factor at 1/2, 3/4 and full load.
- Rated temperature rise.
- Locked rotor current at rated voltage.

B. Maximum seating torque.

C. Friction factors and packing gland thrust allowance used in sizing operator.

D. The actual time and rim torque required for hand operation.

1.5 WARRANTIES

All equipment and installation shall be provided with warranties for a period of one (1) year minimum. Warranty period shall commence on the date of owners acceptance.

2.0 PRODUCTS

2.1 ELECTRIC MOTOR OPERATORS (AC MODULATING CONTROL TYPE)

2.1.1 General

Where indicated on the data sheet, modulating electric motor operator shall be the AC modulating type complete with a local control station with open/close/auto/hold functions. Modulating operators shall meet the requirements described herein.



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS			
2.0 PRODUCTS (continued)			
2.1.2 Control Module			
<p>Motor control shall be of the solid state type with proportional pulse output to control the position of a valve. Motor control for modulating valves shall also be furnished as an integral part of the actuator and shall consist of a solid state reversing starter, transformer for control power, red and green indicator lights, positioner, position feedback potentiometer, "open/stop/close" and "local/stop/remote" selector switches, monitor relay and phase discriminator. The positioner will accept the 4-20 maDC command signal, compare it with the preset valve position via the feedback potentiometer and energize the actuator in the open or close direction according to the error. Minimum deadband adjustments will be 0.5 percent of full valve range. In case of loss of control signal, the fail mode shall be field switchable to fail open, fail close, or fail locked in last position.</p>			
2.1.3 Starter			
<p>The operator shall control a solid state reversing starter designed for minimum susceptibility to power line surges and spikes. The starter and control module shall be rated for continuous modulating applications. Power supply shall be 120-volt, single phase, 60-Hz.</p>			
2.1.4 Hand-Wheel Operation			
<p>A permanently-attached hand-wheel shall be provided for emergency manual operation. The hand-wheel shall not rotate during electrical operation. A warning label shall be mounted on the actuator stating the maximum torque that can be applied to fully seat the valve without damage. Devices relying on coil springs shall not be used in the torque switches. Position limit switches and associated gearing shall be an integral part of the valve operator. To provide the best possible accuracy and repeatability, limit switch gearing shall be of the "counting" intermittent type, made of stainless steel or bronze, grease lubricated, and enclosed in its own gearcase or protective housing to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over travel. Limit switches shall be of the heavy duty closed contact type. The maximum torque required, under the most adverse conditions on the rim of the hand-wheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast on the hand-wheel to indicate the direction to turn said hand-wheel.</p>			



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS			
2.0 PRODUCTS (continued)			
2.2 ELECTRIC MOTOR OPERATORS (ON-OFF TYPE)			
2.2.1 Design			
A. The operator shall consist of an electric motor driver, stem nut reduction gearing, and handwheel, together with electrical control equipment including torque and limit switches, space heaters, wiring terminals, control power transformer, and integral motor starter controls; all furnished as a self-contained, totally enclosed unit.			
B. Entire operator assembly shall be suitable for outdoor service in general purpose atmospheres.			
C. The valve and operator mounting assembly shall be designed to withstand, without damage, the stall torque of the operator with the torque and limit switches inoperative.			
D. Space heater(s) shall be provided in the control enclosure(s). The space heater(s) shall be ceramic and sized to prevent condensation. Minimum rating shall be 10-watts. Housings shall be certified NEMA 4X water-tight.			
E. The control compartments shall preferably have hinge covers with O-ring or gasketed seal and be provided with a minimum of three conduit entries, nominal one-inch size. Each entry shall be supplied with a threaded metal conduit plug, and at least one of the conduit entries shall be on the opposite side of the other two.			
F. All electrical components shall be prewired by the operator vendor to a legibly marked terminal strip. Power and control wiring shall be segregated by location or additional shrouds and insulated from each other. All wiring shall be identified and installed in accordance with drawings furnished by vendor, and access for maintenance shall be provided.			
G. All wiring shall be stranded, Teflon or silicon rubber insulated, rated 200°C minimum unless otherwise specified. Power wiring size shall be appropriate for motor size. Wiring shall be #18 AWG minimum.			



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS

2.0 PRODUCTS (continued)

H. Temperature compensating stem nuts shall be supplied when valve size and operating temperature exceed the maximum values for standard operators in the following tables:

<u>Valve Size</u>	<u>Max. Temp. for Standard Operator</u>
to 8"	1000°F
10" - 12"	800°F
14" - 18"	750°F
20" - 30"	600°F

For valves which may be closed while hot, and then permitted to cool down to ambient, an application service factor of 2.0 should be applied to stem nut torque.

I. A galvanized schedule 40 steel pipe cover, or approved equal, shall be provided for the stem extension above the operator for rising stem valves.

2.2.2 Reduction Gears for Operators

A. Gears shall be fully enclosed and immersed in a lubricant. All power gearing shafts shall be mounted on ball or roller bearings. Limit switch drive gearing shall be stainless steel or bronze.

B. Motor and gears shall be designed such that the stall torque value is a minimum of 150 percent of the rated torque. The gearing shall have a built-in, lost motion device that permits the motor to attain full speed in a minimum travel of 135 degrees before imparting a hammer blow to start the valve in motion, either opening or closing direction. Lost motion device shall be between the worm gear and the valve.

C. Operator gearing shall be self-locking; i.e., a torque switch shall remain open after it has been activated to permit the use of maintained contact control circuits. Non-locking gearing may be used for special applications with prior approval from the Owner/Engineer.

2.2.3 Handwheel

A. The operator shall be equipped with a permanently attached handwheel of the automatic declutching type that precludes mechanical engagement of the handwheel while the drive is in operation.



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS

2.0 PRODUCTS (continued)

The declutching device shall:

- Allow power override of the handwheel operation at all times.
- Permit manual handwheel operation of the main valve in the event of a frozen or seized driver.

B. Handwheel drive shall permit the valve to be stroked open or closed in 15 minutes or less, based on a handwheel speed of 75 RPM.

C. Handwheel clockwise rotation shall close the valve and counterclockwise rotation shall open the valve.

2.2.4 Valve Position Indication

A. When specified, mechanical dial or pointed indication of valve position shall be incorporated in the operator.

B. When specified, lamp indication of CLOSED (red) and OPEN (green) shall be provided. In the intermediate position, both red and green lamps shall be on. In rare cases a third lamp (amber) will be specified to indicate the intermediate position of the valve. Lamps shall be rated 100,000 hours unless excepted by prior approval from the Owner/Engineer.

2.2.5 Controls

A. A reversing motor starter with electrical and mechanical interlocks shall be provided in the operator housing unless otherwise specified. The starter shall be suitable for operation in a moist, salty, and corrosive atmosphere, typical of locations in coastal areas.

B. Control power shall be single-phase, 120-volts, 60-hertz, supplied from an integrally-mounted control power transformer unless otherwise specified.

Control power transformers shall be 480/120 volts, epoxy encapsulated or vacuum pressure impregnated, and shall have fuse protection on the primary (2) and secondary. Fuses shall be readily accessible for replacement or deactivation at the terminal board.



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS

2.0 PRODUCTS (continued)

C. Torque and limit switches:

- Switch design shall permit in-place change of "normally open" or "normally closed" operation.
- Minimum switch contact break rating shall be: 5-amps at 480 VAC, 15-amps at 120-VAC, and 1/4-amp at 125-VDC inductive.
- Torque and limit switches shall be easily adjustable without special tools or removal of the switch assembly from the operator. Repeatability of switch operation shall be $\pm 1/2$ percent of set point.
- Position limit switches shall be provided at each end of travel for remote indication and sequencing. A minimum of eight limit switch contacts shall be furnished, with operation as follows:

Three contacts open only when valve is fully closed.

One contact open except when valve is fully open.

One contact closed only when valve is fully closed.

Three contacts closed except when valve is fully open.

When specified, design shall include additional limit switches, each adjustable over full valve travel.
- "Open" and "close" torque switches shall be provided with means to prevent tripping on torque during initial valve unseating.

D. When specified, integral individual pushbuttons or single 3-way pushbutton with twist action shall be provided for OPEN-STOP-CLOSE operation of the valve. Pushbuttons shall have stainless steel shafts and bronze bushings unless excepted by prior approval from the Owner/Engineer.

2.2.6 Operator Performance

A. The operator shall be sized to open or close the valve through its full stroke at maximum specified process pressure drop and temperature.



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS

2.0 PRODUCTS (continued)

A. Stem travel for gate valves shall be 12-inches per minute, unless otherwise specified.

B. The operator shall be capable of normal operation at any mounting angle.

C. The operator shall be capable of functioning in an ambient temperature ranging from minus 22°F (minus 30°C) to plus 158°F (plus 70°C).

2.2.7 Motors

A. Motors shall be three-phase, 460-volts, 60-hertz, single speed, high starting torque, with lifetime prelubricated (sealed) ball bearings. Class "B" or Class "F" insulation shall be provided unless specified otherwise.

B. Motor shall be suitable for the following:

- Three successive open-close operations of the valve or for 15 minutes continuous operation, whichever is the shorter time period.
- Six consecutive applications of locked rotor current (i.e. as in jogging).
- One or more winding temperature detectors embedded in the motor winding shall be provided for motor overload protection. Detectors must be capable of being deactivated at the terminal board.

2.2.8 Operation Nameplate Identification

A. Operators shall have the following identifying information on a nameplate fastened to the operator:

- Equipment identification number
- Manufacturer's name, model, and serial number.
- Area electrical classification suitability of motor and control enclosure.
- As applicable, nameplates shall also carry information relating to operator type, voltage and frequency, rated HP (KW) and maximum differential pressure.



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SPECIFICATION FOR ELECTRIC MOTOR VALVE OPERATORS

2.0 PRODUCTS (continued)

B. Nameplate material shall be stainless steel, monel, brass or bronze. Nameplates shall be attached with stainless steel fasteners (adhesive fastening is not acceptable).

3.0 EXECUTION

(Not Used.)

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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
HIGH DENSITY POLYETHYLENE PIPE**

1.0 GENERAL

1.1 This specification covers the design, purchasing, fabrication, installation, examination and leak testing requirements for dual containment high density polyethylene piping system. The design, installation and testing of the Leak Detection System specified in related sections shall be included. Materials identified in ASTM D-2657 shall be purchased according to this specification. Installation shall be performed in accordance with this specification. The containment piping and leak detection is one system. The Contractor shall be responsible for the overall operation of the complete system. No deviation from this specification shall be allowed without express written consent of the Engineer.

1.2 Related Sections

1.2.1 Trenching, Backfilling and Compaction Specification No. 02221

1.2.2 Specification for Leak Detection System Specification No. 134231

1.2.3 Specification for Piping Materials PE-01 Line Class PD

1.2.4 Piping Line List

1.3. Reference Standard (Latest Edition)

1.3.1 For the Piping System, Related Codes, Standards and Specifications:

- ASME B31.3 Process Piping
- AWWA C-901 Polyethylene (PE) Pressure Pipe and Tubing 1/2" through 3" for Water Service
- AWWA C-906 Polyethylene (PE) Pressure Pipe and Fittings, 4" Through 63", For Water Distribution
- ASTM F-714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
- NSF Std. #14 Plastic Piping Components & Related Materials
- ASTM D-638 Test Method for Tensile Properties of Plastics



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1.0 <u>GENERAL</u> (Cont.)			
<ul style="list-style-type: none">• ATM D-790 Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials• ASTM D-1238 Test Method for Flow Rates of Thermal Plastics by Extrusion Plastometer• ASTM D-2321 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications• ASTM D-1248 Specification for Polyethylene Plastics Molding and Extrusion Materials• ASTM F-1248 Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe• ASTM D-1505 Test Method for Density of Plastics by the Density Gradient Technique• ASTM D-1599 Test Method for Short Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings• ASTM D-1693 Test Method for Environmental Stress Cracking of Ethylene Plastics• ASTM D-2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings• ASTM D-2239 Polyethylene (PE) Plastic Pipe (SIDR-PR). (Iron Pipe Size; Inside Diameter)• ASTM D-2657 Hot Joining Polyolefin Pipe and Fittings• ASTM D-2737 Polyethylene (PE) Plastic Tubing			



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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
HIGH DENSITY POLYETHYLENE PIPE**

1.0 GENERAL (Cont.)

- ASTM D-2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
- ASTM D-3035 Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
- ASTM D-3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- ASTM D-3350 Polyethylene Plastics Pipe and Fittings Materials
- ASTM D-4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- FM, Factory Mutual Approved
- Plastic Piping Institute PPI TR 31 Underground Installation of Polyolefin Piping

1.4 Experience of supplier shall not be less than five (5) years with these systems and materials.

1.5 The dual containment piping system shall be a Fluid-Loc™ system from Fluid Controls, Inc. or approved equal. The leak detection system shall be Trace Tek™ System from Raychem Corporation (as supplied by Fluid Controls, Inc.) per Specification No. 134231.

2.0 SCOPE OF WORK

The scope of this specification shall be for the following:

2.1 The purchase of prefabricated high density polyethylene dual contained piping system, designed for simultaneous butt fusion welding, and capable of accepting the installation of the leak detection system.

2.2 Field training for the installation of the dual containment piping system, which includes the installation of detection cables, fusion welding of joints and testing of piping system.



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2.0 <u>SCOPE OF WORK</u> (Cont.)			
2.3 A pre-construction meeting shall be held to discuss the project and develop an installation plan and QA/QC plan. The Contractor, the Piping Supplier, the Engineer and the Owner or his representative shall attend.			
3.0 <u>DESIGN OF PIPING SYSTEM</u>			
3.1 The design of piping shall conform to the requirements of ASME B31.3.			
3.2 The pipe system requirements are:			
<ul style="list-style-type: none">• A carrier pipe pressure requirement of 75 psi• Design temperature shall be 55°F• A minimum burial depth of four (4) feet			
4.0 <u>DEFINITIONS</u>			
4.1 The following definitions apply to this specification:			
<ul style="list-style-type: none">• Contractor Overall Contractor as selected by the Owner that has overall responsibility for materials, installation, testing and inspection.• Engineer Owner selected Engineer that oversees all design and material selection.• Manufacturer The maker of the piping product or detection system.• Manufacturer's Technician The Technician designated by the manufacturer of the product.• Owner AFCEE• Specifying Engineer The Owner designated Engineer that specified materials, operations and installation procedures.			



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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
HIGH DENSITY POLYETHYLENE PIPE**

4.0 DEFINITIONS (Cont.)

- System Supplier The Vendor as selected by the General Contractor that provides the design and fabrication of the dual containment piping system and leak detection.

5.0 MATERIALS

5.1 Pipe and Fittings

All pipe used to fabricate the dual containment piping system supplied under this specification shall be high density, extra high molecular weight polyethylene pipe (equal to Driscopipe 1000 as manufactured by Phillips Driscopipe, Inc.). The pipe and fittings shall conform to ASTM D-3350 with minimum cell classification values of 345434C; the pipe and fittings shall be made from the same polyethylene resin base which meets this specification.

5.2 Physical Properties of Pipe Compound

5.2.1 Density

The density shall be no less than 0.955 gms/ccm as referenced in ASTM D-1505

5.2.2 Melt Index

The melt index shall be no greater than 0.15 gms/10 minutes when tested in accordance with ASTM D-1238 - Condition.

5.2.3 Flex Modules

Flexural modulus shall be 110,000 to less than 160,000 psi as referenced in ASTM D-638.

5.2.4 Tensile Strength at Yield

Tensile strength shall be 3,200 to less than 3,500 psi as referenced in ASTM D-638.

5.2.5 ESCR

Environmental Stress Crack Resistance shall be in excess of 1,500 hours with zero failures when tested in accordance with ASTM D-1693 - Cond. C.



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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
HIGH DENSITY POLYETHYLENE PIPE**

5.2 Physical Properties of Pipe Compound (Cont.)

5.2.6 Hydrostatic Design Basis shall be 1,600 psi at 23 degrees C when tested in accordance with ASTM D-2837.

5.2.7 Tested according to ASTM F-1248, ring specimen ESCR is zero failures in more than 1,000 hours.

5.2.8 No slow-crack-growth pipe ring failures in more than 32 days of testing at 1600 psi, cycled at nine (9) RPMs according to Battelle Rotary Test.

5.2.9 The HDPE pipe extruder and resin manufacturer shall be the same company. Third party testing data may be required by the Engineer to certifying the manufacturer's material data.

5.2.10 Chemical resistance data from the Pipe Manufacturer on the application will be provided as part of the submittal. The Engineer may require a certification letter from the manufacturer as part of the submittal.

5.3 Deviations

If a Contractor chooses to submit a bid that does not meet all of the requirements of this specification, the bid shall include a written description of the deviations with data that show the magnitude of the deviations and the justification for the deviation from the specification. The decision to accept material deviating from the specification shall be the responsibility of the Specifying Engineer and must be approved in writing.

5.4 Dual contained pipe and fitting may be rejected for failure to meet any of the requirements of this specification.

6.0 DUAL CONTAINMENT PIPING SYSTEM

6.1 The dual Containment piping system shall be Fluid-Lok™ Dual Contained pipe and fittings as manufactured by Fluid Controls, Inc.; Huntsville, AL. or approved equal.

6.1.1 Pipe supplied under this specification shall have IPS (Iron Pipe Size) OD and shall meet ASTM D-3035. Pipe sizes shall be as specified in the following table. The dual containment combination, inner by outer pipe, the ID and OD of the carrier and containment, and the SDRs shall be specified herein:



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SPECIFICATION FOR DUAL-CONTAINMENT PIPING
HIGH DENSITY POLYETHYLENE PIPE

6.0 DUAL CONTAINMENT PIPING SYSTEM (Cont.)

CARRIER PIPE SIZE	CARRIER ID	CARRIER OD	CARRIER SDR	CONT. PIPE SIZE	CONT. ID	CONT. SDR
2"	1.9"	2 3/8"	11	6"	5.8"	26
6"	5.8"	6 5/8"	17	10"	9.9"	26
8"	7.6"	8 5/8"	17	12"	11.7"	26

6.1.2 Fittings shall be manufactured to the same IPS ID and OD as the pipe.

6.1.2.1 All fittings shall meet the pressure requirements of the system as specified and based on ASTM D-2837 Hydrostatic Design Basis for thermoplastic Pipes.

6.1.2.2 All molded fittings shall be manufactured per ASTM D-3261.

6.1.2.3 Pipe joints and fittings shall be supplied to the job site ready for simultaneous butt fusion. The Fabricator shall show that the materials are capable of butt fusion and shall provide a procedure to consistently produce sound welds.

6.1.2.4 Cleanouts shall be installed every 600 foot or as per the drawings. Cleanouts shall be capped with metallic blind flanges and a full blind gasket (to prevent a condensation of the inside of the metal blind) for easy access. (Alternate: Position cleanouts in leak detection manholes, valve boxes or well heads.)

6.2 Carrier pipe support shall be with full round centralizers welded to the carrier pipe. centralizer support spacing per Plastic Piping Institute standards and Fluid Controls standard.



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SPECIFICATION FOR DUAL-CONTAINMENT PIPING HIGH DENSITY POLYETHYLENE PIPE			
6.0 <u>DUAL CONTAINMENT PIPING SYSTEM</u> (Cont.)			
6.2.1 The centralizers shall be machined for accuracy from pipe grade resin 1/2" sheet stock HDPE. Centralizers have openings at 6 o'clock and 12 o'clock per the drawings. The opening at 6 o'clock will permit the flow of liquid between the carrier pipe and the containment pipe. the minimum vertical opening shall be .75 inches or greater including allowance for internal beads. The minimum horizontal opening shall be 1.25 inches. the opening at 12 o'clock shall be the same dimensions.			
6.2.2 The OD of the centralizer shall match the ID of the containment piping as closely as possible.			
6.3 Force Transfer Couplings® manufactured by Fluid Controls shall be used to anchor the differential and the total forces from thermal expansion/contraction. The Force Transfer Couplings® shall be a mass anchor machined from solid high density polyethylene pipe grade resin. The coupling shall anchor the inner carrier pipe and the out containment pipe to an external anchor point. Force Transfer Couplings® shall be used to protect fittings from thermal expansion as required by the manufacturers thermal analysis of the system based on the standards outlined in this specification.			
6.3.1 Force Transfer Couplings® shall be simultaneously fused into the system.			
6.3.2 Solid Force Transfer Couplings® shall be used to segment the annular space as required and drawn.			
6.3.3 Force Transfer Couplings® shall be ported unless indicated on the drawings. Ports shall provide a continuous annular space and match the openings in the centralizers. POSITION PORTS PROPERLY DURING INSTALLATION.			
6.4 End termination/Force Transfer Couplings® shall be used to seal the system at both ends. The coupling shall be simultaneously butt fused to the carrier and containment pipe to seal the annular space. No other closure or termination will be allowed. This fitting will also provide the transition to single wall piping.			



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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
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6.0 DUAL CONTAINMENT PIPING SYSTEM (Cont.)

6.5 Tie-ins to other piping systems and/or equipment where butt fusion is not applicable shall be with HDPE flange adapters and coated metal back-up rings, unless otherwise specified by the Engineer on the drawings. Mechanical compression or clamp style fittings will not be allowed under this specification.

7.0 LEAK DETECTION SYSTEM REQUIREMENTS

See specification for Leak Detection System, Specification No. 134231 for the details of actual leak detection system used.

7.1 Piping and Fittings

7.1.1 All pipe and fittings shall have a pre-installed pull rope of 0.25 inch hollow braid polypropylene rope. All pipe and fittings shall come capped with rain tight pipe and caps.

7.1.2 Access ports are required to provide access to the annular space. These provide the pull points for sensing cable systems or the points for low point detection. Access ports shall be six (6) inches nominal OD (minimum four (4) inches) sealed with blind flanges that extend to 6" below grade. Each access port shall be protected by a cover box as drawn. Locate as drawn.

7.1.3 Low point drains provide drainage for the annular space. Locate as drawn.

7.1.4 Locate solid Force Transfer Couplings® as indicated on the drawings to compartmentalize the containment as required for the leak detection system.

8.0 EXECUTION

8.1 Pipe shall be prefabricated prior to shipment to the jobsite. No on-site fabrication or alterations to the pipe, fittings or system shall be allowed without express written consent of the Engineer and the System Supplier.



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SPECIFICATION FOR DUAL-CONTAINMENT PIPING HIGH DENSITY POLYETHYLENE PIPE			
8.0 <u>EXECUTION</u> (Cont.)			
8.2 Pipe shall be stored on clean, level, dry ground to prevent undue scratching or gouging of the pipe. The pipe ends shall be capped to prevent water and dirt from contaminating the leak detection space between the pipes. If the pipe must be stacked for storage, such stacking should be done in accordance with the pipe manufacturer's recommendation. The handling of the pipe should be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.			
8.3 Segments of pipe having cuts or gouges in excess of 20% of the wall thickness of the pipe shall be cut out and removed. The undamaged portion of pipe can be rejoined after a new end piece has been welded to the pipe.			
8.4 Sections of polyethylene pipe shall be joined into continuous lengths on the job site following the guidelines of ASTM D-2657, using simultaneous butt fusion as the method of joining the dual contained polyethylene piping system. The pipe shall have from 1/2" to 1" of the carrier pipe extending out past the containment pipe to test the alignment and test for movement. No movement of the carrier pipe is acceptable prior to welding.			
8.4.1 System Supplier shall approve all fusion equipment used for the containment system. The butt fusion equipment used to join the pipe shall be capable of meeting all normal butt fusion requirements; alignment, heating, trimming and fusion pressure.			
8.4.2 Simultaneous fusion equipment shall be capable of simultaneous installation of the leak detection sensor pull rope during the fusion welding process, leaving a free running pull rope from access port to access port upon completion of the pipe joining process.			
8.5 Fused segments of pipe shall be moved to avoid damage to the pipe. Handle dual containment pipe with care. Limit bending of the pipe. Nylon slings are preferred.			
8.6 A representative of the dual containment System Supplier shall be on site to train the Contractor's personnel. A minimum of two (2) week(s) training will be required on site.			
8.6.1 A Manufacturer's Technician shall be required on site for the duration of the job for QA/QC and installation oversight. (If required by project difficulty.)			



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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
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8.0 **EXECUTION** (Cont.)

8.6.2 A Manufacturer's Technician shall be required on site for five (5) days to assist with the piping system pressure test. (If required by project difficulty.)

8.6.3 A Manufacturer's Technician shall be required on site for five (5) days to assist with the installation of any leak detection sensors or cable in the piping system. (If required by project difficulty.)

8.7 Modification to the system shall be done only by a representative of the dual containment System Supplier or factory trained installer. This includes changes in lengths of pipe and special tie-in connections.

8.8 The piping system shall be suitable for direct burial. Trenching, backfilling, and compaction shall be per Section 02221.

8.9 **Leak Detection Components Installation**

8.9.1 The clean and dry installation of the containment piping's annular space is critical. The Contractor shall insure that the pipe's annular space is clean and dry

8.9.2 The Contractor shall insure that the pull rope is free running from access port to access port. The pull rope shall be continuous and knot free between access ports and be unobstructed and loose in the pipe.

8.9.2.1 The Contractor shall take care that the weld bead does not obstruct the .75" clearance required for the pull rope and sensing cable at the 6 o'clock position in the containment space.

8.9.3 The Contractor shall install the leak detection sensor in the piping with the cable feed-through assemblies located in the beginning access port in each line. The sensor will be tested in place to insure the clean and dry condition of the system and the quick connection/start-up to the system by the Electrician/Owner.

8.10 **Examination and Leak Testing**

The extent of required examination and the general requirements for leak test shall conform with the applicable requirements stated in ASME B31.3.



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SPECIFICATION FOR DUAL-CONTAINMENT PIPING HIGH DENSITY POLYETHYLENE PIPE			
8.0 <u>EXECUTION</u> (Cont.)			
8.10.1 The Carrier (inside pipe) shall be hydrostatically tested at 1.5 times the operating pressure per the line list. The system should be brought up to pressure and allowed to equalize for three (3) hours, then the pressure shall be monitored for a three (3) hour test period. Since HDPE is a flexible material, pressure drop can occur for reasons other than a leak, such as a temperature change. Acceptable make-up water tables per PPI TR 31 shall be provided by the Piping System Supplier. If no significant pressure drops occur or there are no visual signs of leaks during the final test period, then the pipeline passes the test.			
8.10.3 The annular space between the carrier and containment pipe shall be tested at 10 psi air pressure. Air pressure should be allowed to equalize for 10 minutes, then monitor the pipe for the test period of 10 minutes, during which no drop in pressure shall be allowed.			
8.10.4 The final leak detection system test will be performed by the electrician. The piping contractor will have the Leak Detection Supplier supervise and certify the installation of the leak detection sensors and the clean and dry condition of the pipe using the leak detection system's portable test box.			
9.0 <u>SUBMITTALS</u>			
9.1 <u>General</u>			
Applicable manufacturer's data required to demonstrate compliance with this specification. Submit on supplier's experience with these systems.			
9.2 <u>Scope of Work</u>			
Submit system bill of materials. Submit arrangements for training and QA/QC support from piping supplier. Piping Supplier shall provide a flow, burial and thermal stress analysis of the system's application parameters for the Engineer's approval.			
9.3 <u>Pipe and Materials</u>			
Submit on cell class according to ASTM D-3350 and applicable standards identified by the cell class.			



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**SPECIFICATION FOR DUAL-CONTAINMENT PIPING
HIGH DENSITY POLYETHYLENE PIPE**

9.0 SUBMITTALS (Cont.)

9.4 Dual Containment Piping System

Submit carrier and containment pipe sizes per ASTM D-3035. Submit hydrostatic design basis per ASTM D-2837. Submit on any molded fittings in the system that shall meet ASTM D-3261. Submit details of typical fittings including centralizers, force transfer coupling, etc.

9.5 Leak Detection System Requirements

Submit data indicating compliance with this specification Paragraph 7.

9.6 Execution

Submit data on system fusion welding procedure(s) and welding equipment required. Submit handling and storage data. Submit trenching and burial data per Section 02221. Submit comprehensive system testing guidelines. Submit manufacturer's field technical support schedule for training, QA/QC oversight, testing and leak detection sensor installation.

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PIPING MATERIAL SPECIFICATION

SPEC. NO. PD

ITEM STC	SIZES (NPS)	RATING/ SCHED	FACE/ END	GENERAL DESCRIPTION	COMM CODE	NOTES	R E V
PITTINGS							1
45E	6 - 8			INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION. 30 DEG. ELL, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3302		
45E	6 - 8			45 DEG. ELL, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3303		
TEE	2			TEE, HDPE, SDR11 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3204		
TEE	6 - 8			TEE, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3304		
CAP	2			CAP, HDPE, SDR11 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3205		
CAP	6 - 8			CAP, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3305		
CRE	6 - 8			CONC.RED., HDPE, THK=SDR17 X R.WT=SDR17 MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3306		

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09/26/96		A		PE-01			
<p style="text-align: center;">PIPING MATERIAL SPECIFICATION</p> <p style="text-align: center;">SPEC. NO. PD</p>							
ITEM STC	SIZES (NPS)	RATING/ SCHD	FACE/ END	GENERAL DESCRIPTION	COMM CODE	NOTES	R E V
FITTINGS							
ERE	6 - 8			ECC. RED., HDPE, THK=SDR17 X R.WT=SDR17 MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3307	1	
VALVES							
BUV	2 - 8	150	RF	BUTTERFLY VALVE, WAFER TYPE TAG: VBU-4	VBU-4		
FLANGES							
EXF	2	150	FF	FLANGE ADAPTER, MOLDED HDPE, SDR11 THICKNESS, W/STEEL BACK-UP RING, DRILLED TO ANSI B16.5, CLASS 150.	JW2901		
EXF	6 - 8	150	FF	FLANGE ADAPTER, MOLDED HDPE, SDR17 THICKNESS, W/STEEL BACK-UP RING, DRILLED TO ANSI B16.5, CLASS 150.	JW2902		
GASKETS							
GAS	2			GASKET, 1/16" THK., FULL FACE; NBR BINDER; FOR FF FLANGES; ANSI B16.21 NON-ASBESTOS; GARLOCK BLUE-GARD 3000 OR EQUAL.	RG002		
BOLTING							
STU	2			STUD BOLTS, FULL THREAD, ALLOY STEEL, ASTM A193-B7 W/2 ASTM A194 GR 2H HEAVY HEX NUTS	CB7001		

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PIPING MATERIAL SPECIFICATION
SPECIFICATION NO. PD

BRANCH CONNECTION		NOTES	CHART	REV
LEGEND				
RT- BRANCH SADDLE REDUCING TE	E			
T- TEE				

SPECIFIC PIPING NOTES

REV

1. ALL PIPE AND FITTINGS SHALL IN ACCORDANCE WITH SECTION 15060 "SPECIFICATION FOR DUAL-CONTAINMENT PIPING-HIGH DENSITY POLYETHYLENE PIPE".
2. TRENCHING, BACKFILLING AND COMPACTION OF PIPING SHALL BE IN ACCORDANCE WITH SECTION 02221.
3. LEAK DETECTION SYSTEM SHALL BE IN ACCORDANCE WITH SECTION 134231.
4. CONTAINMENT PIPE SHALL BE IN ACCORDANCE WITH SECTION 15060.

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<p align="center">PIPING MATERIAL SPECIFICATION</p> <p align="center">SPEC. NO. PS</p>							
ITEM	SIZES	RATING/	FACE/	GENERAL	COMM	R	
STC	(NPS)	SCHED	END	DESCRIPTION	CODE	NOTES	E V
FITTINGS							
ERE	6 - 8			ECC. RED., HDPE, THK=SDR17 X R.WT=SDR17 MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3307		
VALVES							
BUV	2 - 8	150	RF	BUTTERFLY VALVE, WAFER TYPE TAG:VBU-4	VBU-4		
FLANGES							
EXF	2	150	FF	FLANGE ADAPTER, MOLDED HDPE, SDR11 THICKNESS, W/STEEL BACK-UP RING, DRILLED TO ANSI B16.5, CLASS 150.	JW2901		
EXF	6 - 8	150	FF	FLANGE ADAPTER, MOLDED HDPE, SDR17 THICKNESS, W/STEEL BACK-UP RING, DRILLED TO ANSI B16.5, CLASS 150.	JW2902		
GASKETS							
GAS	2			GASKET, 1/16" THK., FULL FACE; NBR BINDER; FOR FF FLANGES; ANSI B16.21 NON-ASBESTOS; GARLOCK BLUE-GARD 3000 OR EQUAL.	RG002		
BOLTING							
STU	2			STUD BOLTS, FULL THREAD, ALLOY STEEL, ASTM A193-B7 W/2 ASTM A194 GR 2H HEAVY HEX NUTS	CB7001		

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PIPING MATERIAL SPECIFICATION

SPEC. NO. PS

ITEM STC	SIZES (NPS)	RATING/ SCHED	FACE/ END	GENERAL DESCRIPTION	COMM CODE	NOTES	R B V
FITTINGS							
45E	6 - 8			INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION. 30 DEG. ELL, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3302		
45E	6 - 8			45 DEG. ELL, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3303		
TEE	2			TEE, HDPE, SDR11 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3204		
TEE	6 - 8			TEE, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3304		
CAP	2			CAP, HDPE, SDR11 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3205		
CAP	6 - 8			CAP, HDPE, SDR17 THICKNESS, MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3305		
CRE	6 - 8			CONC.RED., HDPE, THK=SDR17 X R.WT=SDR17 MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3306		

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<p align="center">PIPING MATERIAL SPECIFICATION</p> <p align="center">SPEC. NO. PS</p>							
ITEM	SIZES	RATING/	FACE/	GENERAL	COMM		R
STC	(NPS)	SCHED	END	DESCRIPTION	CODE	NOTES	E V
FITTINGS							
ERE	6 - 8			ECC. RED., HDPE, THK=SDR17 X R.WT=SDR17 MANUFACTURED BY INJECTION MOLDING OR BY EXTRUSION AND MACHINING OR FABRICATED FROM HDPE PIPE CONFORMING TO THIS SPECIFICATION.	JW3307		
VALVES							
BUV	2 - 8	150	RF	BUTTERFLY VALVE, WAFER TYPE TAG: VBU-4	VBU-4		
FLANGES							
EXP	2	150	FF	FLANGE ADAPTER, MOLDED HDPE, SDR11 THICKNESS, W/STEEL BACK-UP RING, DRILLED TO ANSI B16.5, CLASS 150.	JW2901		
EXP	6 - 8	150	FF	FLANGE ADAPTER, MOLDED HDPE, SDR17 THICKNESS, W/STEEL BACK-UP RING, DRILLED TO ANSI B16.5, CLASS 150.	JW2902		
GASKETS							
GAS	2			GASKET, 1/16" THK., FULL FACE; NBR BINDER; FOR FF FLANGES; ANSI B16.21 NON-ASBESTOS; GARLOCK BLUE-GARD 3000 OR EQUAL.	RG002		
BOLTING							
STU	2			STUD BOLTS, FULL THREAD, ALLOY STEEL, ASTM A193-B7 W/2 ASTM A194 GR 2H HEAVY HEX NUTS	CB7001		

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PIPING MATERIAL SPECIFICATION
SPECIFICATION NO. PS

BRANCH CONNECTION

LEGEND

RT- BRANCH SADDLE REDUCING TEE S
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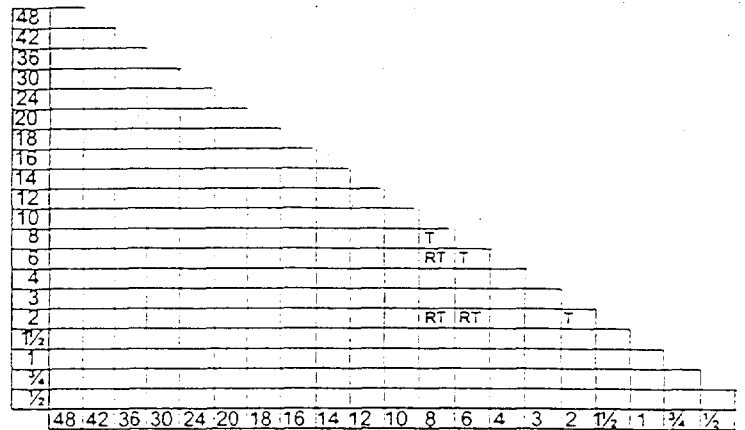
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SPECIFIC PIPING NOTES

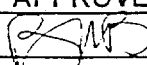

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Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00				NO. 15400	
BY MHH		APPROVED 	ISSUE DATE 8/23/96	SPECIFICATION FOR PLUMBING SYSTEMS	
<p>THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.</p> <p>FOR CONVENIENCE, THE NATURE OF THE REVISION IS BRIEFLY NOTED UNDER REMARKS. THESE REMARKS ARE NOT A PART OF THE DOCUMENT. THE REVISED PAGES ARE A PART OF THE DOCUMENT AND SHALL BE COMPLIED WITH IN THEIR ENTIRETY</p>					
REV.	DATE	BY	APPROVAL	PAGES	REMARKS
0	8/23/96	MHH		All	Issued for Construction



AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K784-00					NO. 15400	PAGE 1 OF 23
					SPECIFICATION FOR PLUMBING SYSTEMS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
MHH		8/23/96	0	8/23/96		

1.0 GENERAL

1.1 Description

A. The work under this section shall include the furnishing and installation of a complete plumbing system consisting of a potable water system, and sanitary sewerage system. The work shall include all labor, materials, equipment, tools, supervision, and appurtenant accessories necessary for, or incidental to, the furnishing and installation of complete and properly operating system(s), as shown on the drawings and in the specifications, and final connections to all related equipment.

B. Coordination: Plumbing Contractor shall examine all drawings and specifications of all divisions of the project to assure himself that provisions have been made for all services under his jurisdiction. Should the Contractor discover an omission of service, the Contractor shall inform the Engineer of his findings in order that provision for extension of the required services may be made prior to bid date.

C. Definitions

1. Where the word "Contractor" is used in connection with the work included under this section of the Specifications, reference is thereby made to the Contractor who is engaged to execute the work included under each section of the specifications, notwithstanding the fact that this Contractor may be either the General Contractor or his Subcontractor. The Contractor for the work included under each Section of the Specifications shall cooperate at all times with all other Contractors employed on the job so that all phases of the work may be properly coordinated without delays or damage to any parts of the work of any Contractor.

2. The word "Owner's Representative" used in connection With the work included under this Section of the Specifications, shall indicate the Owner's designated representative that may be but not limited to Engineer, Contract Officer, or Construction Manager.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

1.0 **GENERAL** (continued)

1.2 **Related Work Specified Elsewhere**

1. Section 02721 Trenching, Backfilling and Compaction
2. Section 15450 Plumbing Fixtures

1.3 **Quality Assurance**

A. **Qualifications of Manufacturer**

1. Pipes, pipe fittings, valves, drains, specialties and supporting devices shall be furnished by a manufacturer who has made these items for a period of at least five years.

- B. The entire installation shall equal or exceed the minimum requirements of The National Plumbing Code, and the Building Codes or regulations, laws, or rules promulgated by regulatory authorities having jurisdiction. In the event such requirements conflict with these specifications, the more stringent shall apply.

- C. Testing of piping systems shall be performed as specified under the various types of piping.

1.4 **Reference Standards** (Latest Edition)

1. The National Plumbing Code and regulations of the jurisdictional authorities.
2. FS QQ-S-571E: Solder, Tin Alloy, Antimony
3. FS WW-H-171D: Hangers, and Supports, Pipe
4. FS WW-P-406D: Pipe, Steel (Seamless and Welded) (For Ordinary Use)
5. FS WW-T-799E.: Tube, Copper Seamless Water and Refrigeration (For use with Solder, Flared or Compression Type Fittings)



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SPECIFICATION FOR PLUMBING SYSTEMS			
1.0 <u>GENERAL</u> (continued)			
6.	FS WW-V-51E:	Valve, Angle, Check and Globe, Bronze (125, 150 and 200 pound, Threaded Ends, Flanged Ends, Solder Ends, and Brazed Ends) for Land Use	
7.	FS WW-V-54D:	Valve, Gate, Bronze (125, 150 and 200 pound, Threaded Ends, Flanged Ends, Solder Ends and Brazed Ends For Land Use)	
8.	FS WW-V-58B:	Valves, Gate, Cast Iron Threaded and Flanged (For Use)	
9.	ASTM A 74:	Cast Iron Soil Pipe and Fittings	
10.	ASTM B 61:	Specification for Steam or Valve Bronze Castings	
11.	ASTM C 564:	Rubber Gaskets for Cast Iron Soil Pipe and Fittings	
12.	ASTM D 1784:	Specification For Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds	
13.	ASTM D 1785:	Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120	
14.	ANSI B 16.22:	Wrought Copper and Brass Solder-Joint Pressure Fittings	
15.	ANSI A 21.6:	Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids (AWWA C 106)	
16.	ANSI A 21.10:	Gray-Iron and Ductile-Iron Fittings, 2 inch through 48 inch for Water and Other Liquids (AWWA C 110)	



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

1.0 **GENERAL** (continued)

- | | | |
|-----|---------------|--|
| 17. | ANSI A 21.11: | Rubber Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings (AWWA C111) |
| 18. | CISPI HSN: | Cast Iron Soil Pipe Institute, Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings |
| 19. | CISPI 301: | Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems |
| 20. | D 4101 | Flame retardant polypropylene chemical waste pipe and fittings |
| 21. | IAPMO IS6 | Hubless Cast Iron Sanitary Systems (Installations) |

1.5 **Submittals**

- A. Six (6) sets of catalog cuts or shop drawings shall be submitted in six (6) complete bound sets to the Contracting Officer for approval prior to purchase. Submittals shall include, but are not limited to, the following:
1. Pipe material and piping layout.
 2. Pipe hangers and supports.
 3. Valves.
 4. Escutcheons.
 5. Shock arrestors.
 6. Air eliminators.
 7. Pipe sleeves.
 8. Floor drains.
 9. Sediment trap.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

1.0 **GENERAL** (continued)

10. Insulation.
11. Clean out deck plates and wall plates.
12. Plumbing fixtures.
13. Fixture trim.
14. Water heaters.
15. Trap primers.

B. Data shall include (where applicable):

1. Published ratings and capacity data.
2. Detailed equipment data for fabricated items.
3. Installation instructions.
4. Wiring diagram.
5. Regularly published catalog data.
6. Dimensions.
7. Identification of each item per drawing and specification mark numbers.
8. Characteristic curves.

C. In design and purchase of equipment, provide for the interchangeability of items of piping equipment, sub-assemblies and parts.

D. Certificates

1. Submit certificates from the manufacturer stating that the pipe joint gaskets and lubricants are satisfactory for use with pipe and fittings as specified herein.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

1.0 **GENERAL** (continued)

1.6 **Product Delivery, Storage, and Handling**

- A. Contractor shall at all times take such precaution as may be necessary to properly protect his material from damage.
- B. Failure to provide protection which is adequate, in the opinion of the Owner's Representative, will be sufficient cause for rejection of materials in question whether or not actual damage has occurred.

1.7 **Job Conditions**

- A. Do not perform soldering when the temperature of the base metal is less than 0°F.
- B. Do not perform soldering when surfaces are wet from rain or ice.

1.8 **Service and Guarantee**

- A. Upon completion of the installations specified herein, this Contractor shall regulate and adjust all controls, valves, regulators, etc., as necessary to obtain properly operating systems. The Contractor shall then place the various systems in complete operating condition subject to the Owner's Representative approval. The installations shall not be considered complete until the Contractor has thoroughly instructed the Owner, or his authorized agent, as to the proper procedure to be followed in operating the various systems and the Owner understands the correct method of regulating, starting, and stopping each system and part thereof under year-around operating conditions.

Contractor warrants all material to be equal to, or better than, specified, and, furthermore, guarantees all material and workmanship against the existence or development of defects for a period of one year, beginning on the date the said materials and workmanship are accepted in writing by the Owner's Representative.

2.0 **PRODUCTS**

2.1 **Materials**

- A. **Piping**



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

2.0 PRODUCTS (continued)

All piping for the various systems furnished and installed by this Contractor shall be of materials as herein specified and of sizes as shown on the Drawings. Unless otherwise specified, all valves shall be the same size as the piping in which said valve is being installed, and all relief valves shall be piped full size to drains. All piping shall be of the best quality, new material, straight, true, and free of all defects. All pipe cuts shall be reamed even with the inside diameter of the pipe. All pipe threads shall be cut full and true. All piping shall be properly supported, and installed with proper provisions to prevent sagging, vibration from water hammer, or damage from expansion and contraction. Piping for the various systems shall be as follows:

1. Potable water system above and below grade shall be copper pipe and fittings as shown on the drawings.
2. Sanitary sewerage, drain, waste, and vent system shall be cast iron pipe or cast iron soil pipe, and fittings as shown on the drawings. No-hub cast iron pipe shall be permitted on above grade installation only.
3. Copper Tubing and Fittings
 - a. Copper tubing, where accessible: FS-WW-T-799E, Class 1, Type L, hard drawn.
 - b. Fittings: ANSI B 16.22
 - (1) Fitting wall thickness after forming not less than that of adjacent piping.
 - c. Solder joints: FS-QQ-S-571E. Lead solder is not permitted.
 - d. Below slab: FS-WW-T - 799E Class 1 Type L soft drawn.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

2.0 PRODUCTS (continued)

4. Cast Iron Piping

- a. All cast iron piping, other than chemical drain and vent piping, shall be bell and spigot Gray Cast Iron Pipe 150 lb. class conforming to ANSI A 21.6/AWWA C-106 or Federal Specification WM-P-421b for Type 1 pipe.
- b. Fittings shall conform to ANSI A 21.10/AWWA C-110.
- c. Gaskets shall be neoprene suitable for bell and spigot cast iron joints. Gaskets shall conform to ANSI A 21.11/AWWA C-111.

5. Cast Iron Soil Piping

- a. Cast iron soil pipe shall be service heavy, hub and spigot pipe conforming to ASTM A 74.
- b. Joints shall be made using double sealing rubber or neoprene gaskets in accordance with ASTM C 564 or CISPI HSN, 70 durometer.
- c. Pipe shall be installed and joints made up in accordance with manufacturer's instructions.
- d. At contractor's option above grade soil pipe may be no-hub cast iron joined with neoprene and stainless steel couplings.

6. No-hub cast iron soil pipe and fittings.

- a. No-hub cast iron soil pipe and fittings shall be standard weight conforming to CISPI 301.
- b. Installation of no-hub systems shall be in accordance with IAPMO IS6.

7. Black Steel Seamless Pipe and Fittings

- a. Exposed and concealed piping: FS WW-P-406, Weight A, Class 1.



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SPECIFICATION FOR PLUMBING SYSTEMS			
2.0 <u>PRODUCTS (continued)</u>			
b. Pipes 2-1/2 inch and smaller connected with screwed fittings, FS WW-P-501, Type 1, Class B.			
c. Pipes 3 inch and larger connected with welded fittings.			
8. Unions			
a. 2-1/2 inch and smaller: Threaded, FS WW-U-531, Type A or B to match piping.			
b. Screwed fittings by the same manufacturer as the pipe.			
c. Two inch and larger unions: Flanged.			
(1) Two, 2-1/2 and three inch union flanges: Steel, FS WW-U-531 or of cast iron, ANSI B 16.1, 125 pound class.			
d. Four inch and larger union: Forged steel, 150 pound class, slip on weld neck flanges, ANSI B 16.5.			
e. Non-ferrous pipe unions: Brass, FS WW-U-516.			
B. <u>Pipe Hangers and Supports</u>			
1. All hangers and supports for pipes shall be made of galvanized iron or galvanized steel consisting of straps, rods, rings, or clamps, as hereinafter described. Attachments to the building structure shall be made without the use of wood or leather plugs. Pipe hangers and support shall be of the following types:			
a. Adjustable, wrought steel, clevis type, cadmium plated: FS WW-H-171D, Type 7 and Type 8 for steel and cast iron piping.			



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SPECIFICATION FOR
PLUMBING SYSTEMS

2.0 PRODUCTS (continued)

- b. Pipe hangers for copper tubing: Steel, copper plated, clevis type, spaced at maximum five feet for tubing sizes through 1-1/2 inch and maximum eight feet for sizes two inch and larger.
- c. Hanger rods minimum diameter 3/8 inch constructed of steel, cadmium plated, threaded full length and diameter required by pipe size and the load imposed: FS WW-H-171D.
- d. Hanger rod nuts and washers: Steel, cadmium plated.

2. Vertical Piping

Shall be supported at its upper extremity to keep the pipe in alignment and to carry the weight of the pipe and its contents. In addition, all vertical drainage piping shall be supported at the base of the stack. Each vertical stack shall be permanently held in position just below the roof line.

3. Horizontal Piping

Where piping runs in multiple and at the same level, provide and install trapeze hangers with clamps to prevent lateral movement. Where piping runs singly and in the horizontal plane, furnish and install clevis hangers similar to Grinnell Figure 260. Pipe support spacing shall occur at fittings and otherwise shall not exceed five feet (5') for cast iron pipe. For other pipe, pipe support spacing shall not exceed the following:



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SPECIFICATION FOR
PLUMBING SYSTEMS

2.0 PRODUCTS (continued)

Pipe Size	Maximum Spacing, Feet	
	Iron or Steel	Copper
1/2" to 1"	8	5
1-1/2"	10	5
2"	12	8
2-1/2"	12	8
3"	12	8
4"	12	8
6"	12	8
8"	12	8

4. Insulated Piping

Insulated piping shall be supported in the same manner as described above except where it rests on hangers, such insulated piping shall be provided with half-thimble saddles of 12 inch minimum length.

C. Valves

1. Valves shall be installed at all locations shown on the drawings and described in the specifications. A union shall be provided at each valve in screwed piping. Flanges shall be provided upstream and downstream at each valve in welded piping. Valves shall be rated for the service of the piping in which they are installed, and shall be as manufactured by Nibco, Crane, Jenkins, or approved equal.
2. Gate valves two inch or smaller: FS WW-V-54, Type II, Class B.
 - a. Bronze with threaded ends, rough bodies and finished trim.
 - b. Materials except handwheels: ASTM B 61.
 - c. Furnished with malleable iron handwheels.



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SPECIFICATION FOR PLUMBING SYSTEMS			
2.0 <u>PRODUCTS (continued)</u>			
3. Gate valves 2-1/2" and larger: FS WW-V-58, Type I, Class 2, cast iron bodies and bonnets.			
a. Seat rings, disc, disc guide and stem furnished in bronze.			
b. O.S. and Y, type, flanged end connections and malleable iron handwheels.			
4. Backflow Preventer			
a. Manufactured by Backflow Engineering and Equipment Division, Hersey Products Incorporated, or Clay-Val Company, Newport Beach, California, Watts Engineering, Houston, Texas or approved equal.			
b. Consisting of assembly having inlet and outlet shutoff valves, two spring-loaded check valves, a differential-pressure relief valve and test cocks.			
c. Body and seats shall be of bronze, springs of stainless steel, disks of neoprene, diaphragm of neoprene-impregnated cotton.			
d. Maximum working water pressure 175 psi.			
5. Globe, Angle, and Check Valves			
a. Two inch and smaller: FS WW-V-51, Class B.			
(1) Bronze with threaded ends, rough bodies and finished trim.			
(2) Materials except handwheels: ASTM B 61.			
(3) Globe and angle valves furnished with malleable iron handwheels.			
6. Pressure Reducing Valves			



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SPECIFICATION FOR PLUMBING SYSTEMS

2.0 PRODUCTS (continued)

- a. Of the direct acting type in which a diaphragm and spring act directly on the valve stem.
- b. Constructed so that delivered pressure will not vary more than one psi for each ten psi variation in inlet pressure.
- c. Wearing parts readily renewable.
- d. Two inch and smaller valves designed for a working pressure of 250 psi, all brass construction except the yoke connecting the valve body to a separate diaphragm chamber having a brass cover and assembled with brass bolts.
- e. Two inch and larger valves designed for a minimum 125 psi, iron bodies and bronze trim.
- f. Adjustable to any outlet pressure.
- g. Gate valve and union on both the inlet and outlet connections.
- h. Provided with a bypass one pipe size smaller than the main water line.
- i. A globe valve and union provided between the inlet and outlet sides of the pressure reducing valve assembly.
- j. Stem-mounted pressure-reducing valve gauges, 3-1/2" dial, solid brass case and connections with T-handle stops.
- k. Pressure-reducing valve strainer: Brass, removable without disconnecting piping.
 - (1) Two inch and smaller strainer: Brass bodies designed for a working pressure of minimum 250 psi.



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SPECIFICATION FOR
PLUMBING SYSTEMS

2.0 PRODUCTS (continued)

- (2) Strainers 2-1/2" and larger: Iron bodies designed for a minimum working pressure of 125 psi.

7. Ball Valves and Ball Check Valves for PVC

- a. Ball valves with screw ends double entry, self lubricating: ASTM D 1784.
- b. Ball check valve union ends ASTM D 1784.

8. Valves for Copper Piping

- a. Gate valves with solder ends: FS WW-V-54, Bronze, Type I, Class C.
- b. Gate valves with flanged ends: FS WW-V-54, Bronze, Type I, Class B.
- c. Globe, angle and check valves with solder or flanged ends: FS WW-V-51, Bronze, Class C.

C. Floor, Ceiling, and Wall Plates

1. All pipes passing through floors, ceilings, or partitions, and exposed to view shall be provided with nickel plated escutcheons.

D. Air Chambers and Shock Arrestors

1. All water piping shall be adequately protected against water hammer by Drainage and Plumbing Institute approved sealed air chambers as shown on the drawings. In addition, all fixture supplies shall be provided with air chambers, located at an elevation above faucets, and consisting of an 18" length of vertical pipe with cap. All air chambers shall be concealed with the piping.

E. Roof Flashing



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SPECIFICATION FOR PLUMBING SYSTEMS			
2.0 <u>PRODUCTS (continued)</u>			
1. The Roofing Contractor shall furnish flashing for all pipes, vents, etc., required under this Section of the Specifications.			
F. <u>Pipe Sleeves</u>			
1. Where piping passes through walls, floors, ceilings, or roofs, furnish and install schedule 40 iron pipe sleeves of proper size ahead of such construction.			
2. Pipe sleeves shall be a minimum of two sizes larger than the pipe unless otherwise shown on the drawings.			
3. After piping, etc., has been installed, sleeves shall be caulked and sealed, to the satisfaction of the Owner's Representative, to prevent entrance of insects, driving rains, air, and noise transmission.			
G. <u>Insulation</u>			
1. All hot water and cold water, piping above grade shall be insulated with glass fiber, 1" thick insulation with all service jacket, installed in exact accordance with manufacturers' recommendations, including the sealing of all joints with factory furnished joint sealing strips.			
2. All water piping installed outdoors and above ground shall be insulated with fiber glass 1" thick insulation as specified in Paragraph 1. above.			
3. Insulation installed outdoors and above ground shall be protected with aluminum weatherproofing corrugated jacketing with lap seal joints and moisture barrier. Joints shall be sealed with mastic, and fittings shall be covered with prefabricated aluminum fitting covers. Jacketing material shall be a minimum of .020" thickness.			
H. <u>Cleanouts</u>			
1. Floor			



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SPECIFICATION FOR PLUMBING SYSTEMS			
2.0 <u>PRODUCTS (continued)</u>			
a. Josam 56010, Zurn ZN-1400-2, or Wade cast iron ferrule with lead seal, adjustable, Nikaloy flange ring and cover plate with screw. Size as required.			
b. Cleanouts turning up through architecturally finished floors shall be made by means of long sweep "ell" or Y and 1/4" thick machine finished brass plate to cover the opening in the floor.			
2. Wall			
a. Josam 58740, Zurn ZN-1400-3, or Wade cast iron ferrule with lead seal and square smooth wall access cover and frame. Size as required.			
3. Outside Building			
a. Josam 56050, Zurn Z-1420-25, or Wade cast iron ferrule with lead seal and heavy duty traffic cover. Size as required. Where not located in pavement, these cleanouts shall be set in 2'-0" square X 6" thick concrete pad. Concrete shall be finished smooth on top and set flush with finished grade.			
4. Except for test openings, clean-out plugs for pipes up to four inches furnished the same size as pipe.			
3.0 <u>EXECUTION</u>			
3.1 <u>Installation</u>			
A. <u>General</u>			
1. The Contractor performing work under this section of the specifications shall be responsible for the coordination of his work with the other portions of the work. He shall take adequate precautions to protect or replace existing pavements, gutters, side-walks, curbs, utilities, adjoining property, adjacent buildings, etc. and bear all expense necessary to replace or repair damage thereto as a result of his operation.			



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

3.0 **EXECUTION** (continued)

2. Upon completion of his work, this Contractor shall clean out all lines, adjust all controls, valves, etc., and leave the completed systems in satisfactory working order.
3. All piping shall be installed and supported with due provision for expansion and contraction. Piping shall slope to drain and shall have no dips or pockets to prevent complete drainage.
4. Unless otherwise indicated all piping shall be installed in the following manner:
 - a. Suit building conditions.
 - b. Avoid interferences with other trades.
 - c. Maintain access to all parts of piping systems and duct work.
 - d. Maintain pitch.
 - e. Provide additional offsets, fittings, valves, drains, etc., where required by construction coordination and work of other trades.
 - f. Run in pipe chases, recesses, and above ceiling where applicable. Do not cover before examination and testing.
 - g. Run parallel with or at right angles to walls and other piping, neatly spaced and with plumb risers.
 - h. Maintain minimum one inch clearance between hubs, coverings, and adjoining work.
 - i. Support from overhead construction (beams). No hangers from ductwork allowed.
 - j. Maintain maximum headroom.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

3.0 EXECUTION (continued)

- k. Concealed piping in ceilings. Obtain ceiling heights from Contract Drawings.
- l. Provide control valves where noted or required.
- m. Valves: accessible, but no valve handles pointing down.
- n. Provide reducing fittings for changes in pipe size: no bushings permitted.
- o. Use extra heavy pipe for nipples where unthreaded portions of pipe is less than 1-1/2" long. No close nipples.
- p. Provide adequate access doors for valve and other equipment servicing.

B. Soil, Waste, Vent and Drainage Piping Installation

- 1. Grade piping on a continuous slope to at least 1/8" per foot fall towards mains, and no less than slope of the main drain to which it is connected, unless otherwise shown on the drawings.
- 2. Use reducers to change pipe sizes on vent and drain lines.
- 3. Use long sweep bends, Y-fittings, 1/8 or 1/16 bends, or combination Y and 1/8 bends to make changes in direction.
- 4. Join cast iron piping and fittings with neoprene gaskets.
- 5. Cast iron fitting used to connect vent piping shall be brought a minimum of one inch above top of slab.
- 6. In each change of direction greater than 45° of soils and wastes, provide clean-out connected to same with Wye fittings and 45° ell made flush with floor or wall.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

3.0 **EXECUTION** (continued)

8. Provide trap primers and associated piping to all floor drains as indicated on plans.

C. **Potable Water System Installation**

1. Connect and install all service water piping, sizes as shown, to all fixtures, equipment, and outlets.
2. Provide and install the following valves:
 - a. A main shut-off gate valve inside the building.
 - b. A gate valve on each branch take-off.
 - c. A valve in the supply immediately ahead of each fixture.
3. Pipe or tubing shall be free from cuts, dents, or other surface damage. Remove damaged pipe and replace with new pipe or tubing.
4. Cut square and ream ends of copper tubes and steel pipes.
5. Tubing ends shall extend the full depth of the fitting recesses without binding.
6. Use piping solder composition 95-5 (95 percent tin and 5 percent antimony) and non-corrosive flux. (No Lead.)
 - a. Penetrate fully and fill the joint completely with solder.
7. Ream and clean ends of threaded pipes before assembling with fittings and apply approved joint compound to pipe threads only.
8. Make connections to equipment and fixtures without strain to the fixture or equipment.



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SPECIFICATION FOR PLUMBING SYSTEMS

3.0 EXECUTION (continued)

9. Run horizontal piping with a minimum pitch of one inch in 40 feet and arrange for drains at a minimum number of low points with all points drainable.
 - a. Install drain valves and hose nipples not smaller than 3/4 inch at low points.
10. Connect non-ferrous piping to ferrous piping with dielectric couplings.
11. Install pressure reducing valves where main water pressure exceeds 60 psi to maintain a pressure of 15 psi at the most remote fixture.

D. Pipe Sleeves

1. Fill annular space between pipe and sleeves with non-metallic, permanently flexible, compound, tightly seal to form an effective seal against ground water under all operating conditions.

3.2 Field Quality Control

A. Protection of Piping and Equipment

1. Protect pipe, openings, valves, and fixtures from dirt, foreign objects, and damage during the construction period.
2. Replace damaged piping, valves, and fixtures or other appurtenances without cost to the Owner should the damage occur prior to final acceptance of the work.
3. Flush piping with chemically treated water until systems are clean and free of scale, slag, dirt, oil, grease or other foreign material prior to testing.
4. Hand clean expansion joints and strainers.



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SPECIFICATION FOR
PLUMBING SYSTEMS

3.0 EXECUTION (continued)

B. Pressure Testing

1. Test all piping in the presence of the Owner Representative while all portions are visible, using the procedure given below.
2. Test entire piping systems and repeat until found leak free in the presence of and to the satisfaction of the Owner Representative.
3. Notify the Owner Representative at least 36 hours in advance of making tests.
4. Test piping at pressures listed below:
 - a. Sanitary and storm sewerage piping: Requirements of local plumbing code but not less than equivalent to ten feet of water.
 - b. Potable water piping: 1-1/2 times the operating pressure but not less than 100 psi at the top most outlet.

C. Test Procedures

1. Sanitary sewerage piping
 - a. Water test to include the entire system from the lowest point to the highest point in the system, with all fixture connections blocked off.
 - b. After filling the system, shut off the water supply and allow it to stand two hours under test without any loss or leakage.
 - c. Testing may be performed in stages, but the pressure applied at each stage shall be equivalent to that resulting from filling the system to the top of the highest vent.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**

3.0 **EXECUTION** (continued)

d. Conduct a final test on the sanitary system, either by a smoke test or a peppermint test as prescribed by the jurisdictional authority, after fixture connections are unblocked.

2. Potable Water Piping

a. Avoid excessive pressure on safety devices and mechanical seals.

b. Fill the entire system with water and vent all air from the system at least 24 hours before the actual test pressure is applied.

c. Apply 150 psig hydrostatic test pressure when water and average ambient temperatures are approximately equal and constant.

d. Maintain test pressure for a minimum of six hours without drop after the force pump has been disconnected.

e. Visually inspect joints while pipe is under test pressure.

D. **Repair of Leaks**

1. Do not repair leaks in threads, occurring while pipe is under test or thereafter, by mechanical caulking.

2. Do not introduce material inside the piping system which has the purpose of stopping leakages.

3. Repair leaks in threaded piping by breaking the joint, cutting new threads on the pipe and installing a new pipe fitting.

3.3 **Cleaning and Sterilizing Potable Water System**

A. Flush entire hot and cold water piping and other piping and equipment connected downstream from the main shutoff valve with water to remove sediment after completion of tests, replacements or repairs.



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**SPECIFICATION FOR
PLUMBING SYSTEMS**



3.0 **EXECUTION** (continued)

- B. Use chlorine for disinfection in the form of hypochlorite solution or in the form of compressed gas applied through an approved chlorinator.
- C. Operate valves and equipment during chlorination to insure that chlorine reaches all parts of the system.
- D. Feed water and chlorination agent into the system at a rate providing for 50 PPM of chlorine and allow to stand 24 hours before flushing.
- E. Residual chlorine, at the end of the 24 hour retention period shall not be less than 10 PPM.
- F. Flush treated water from the system completely after disinfection.
- G. Continue flushing until samples show that the quality of the water delivered is comparable with the public water supply and satisfactory to the public health authority having jurisdiction.
- H. Do not take samples from hydrants or through unsterilized hose.



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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00				NO. 15450	
				SPECIFICATION FOR PLUMBING FIXTURE AND TRIM	
BY	APPROVED	ISSUE DATE			
MH		8/23/96			
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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO.: 35-K784-00					NO. 15450	PAGE 1 OF 3
					SPECIFICATION FOR PLUMBING FIXTURE AND TRIM	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
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1.0 GENERAL

1.1 General

- A. This section describes the requirements for furnishing and installing plumbing fixtures and trim, as shown on the drawings.

1.2 Related Work Specified Elsewhere

- A. Section (15400) Plumbing System

1.3 Quality Assurance

A. Qualification of Manufacturer

1. Furnish fixtures which are the product of a manufacturer who has made plumbing fixtures for a period of at least five years.

B. Reference Codes and Standards (Latest Edition)

1. Codes and regulations of the jurisdictional authorities.

C. Identification

1. Provide fixtures which have the manufacturer's name or readily identified registered trademark permanently and legibly marked.

1.4 Submittals

A. Shop Drawings

1. Submit complete catalog information and shop drawings for material and equipment.

2.0 PRODUCTS

2.1 Plumbing Fixtures



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**SPECIFICATION FOR
PLUMBING FIXTURE AND TRIM**

2.0 PRODUCTS (continued)

1. General

- a. Fixtures manufactured of twice-fired vitreous chinaware of best quality, non-absorbent, and burned so that the whole mass is thoroughly fused and vitrified producing a material white in color, which when fractured will show a homogeneous mass, close-grained and free from pores.
- b. Brass fittings, faucets, traps and exposed piping, shall be chrome plated over nickel plate, with polished finish.
- c. Brass pipe shall be chrome plated over nickel plat and provided with heavy cast brass escutcheons and set screw plated to match the pipe at fixtures passing into floors, walls, or partitions.

2. Fixtures

- a. Furnish and install fixtures called for and scheduled on the plans.
- b. Provide all necessary fittings, trim, and appurtenances.

B. Vacuum Breakers

1. Chromium plated brass sized to provide minimum air area equal to the piping served and approved by the local jurisdictional authorities.

C. Traps

1. Plain pattern type having a seal minimum 2-1/2 inches and maximum four inches.
2. 1-1/2 inch and two inch traps: Heavy cast brass.
3. All other sizes traps: Same material as specified for piping system to which they are connected.
4. Fixture traps: As specified under plumbing fixtures.

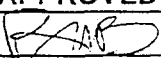



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SPECIFICATION FOR PLUMBING FIXTURE AND TRIM			
3.0 <u>EXECUTION</u>			
3.1 <u>Examination</u>			
1. Verify that walls and floor fixtures are prepared and ready for installation of fixtures.			
3.2 <u>Preparation</u>			
1. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.			
3.3 <u>Installation</u>			
1. Install in accordance with manufacturer's instructions.			
2. Install each fixture with trap, easily removable for servicing and cleaning.			
3. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.			
4. Install components level and plumb.			
5. Install and secure fixtures in place with wall supports, wall carriers, and bolts.			
6. Seal fixtures to wall and floor surfaces with sealant as required, color to match fixture.			
3.4 <u>Interface with Other Products</u>			
1. Review mill work shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.			
3.5 <u>Protection of Fixtures</u>			
1. Protect plumbing fixtures from dirty, foreign objects and damage during construction.			
2. Replace damaged fixtures at no additional cost to the owner.			



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				SPECIFICATION FOR HEATING, VENTILATING AND AIR CONDITIONING	
BY	APPROVED	ISSUE DATE			
WD		10/4/96			
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					SPECIFICATION FOR HEATING, VENTILATING AND AIR CONDITIONING	
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1.0 GENERAL

1.1 DESCRIPTION

Work to be performed by Contractor under this section of work consists of furnishing all labor and materials required and necessary to install a complete and operating heating, ventilation, and air conditioning system as herein noted and called for on the drawings, complete with all accessories, etc., necessary to deliver a complete and satisfactory operating system acceptable to the Owner/Engineer.

1.2 RELATED SECTION

Section 01041	Project Coordination
Section 01060	Regulatory Requirements
Section 01300	Submittals
Section 01600	Material and Equipment
Section 09250	Gypsum Wall Board System
Section 09511	Acoustical Ceiling

1.3 REFERENCE STANDARDS (LATEST EDITION)

SMACMA	HVAC Duct Construction Standards
SMACMA	HVAC System Testing, Adjusting & Balancing
ASHRAE	Systems Handbook
ASTM B 280	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM A 525	General Requirements for Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process
ASTM B 117	Standard Practice for Operating Salt Spray (Fog) Apparatus



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING			
1.0	GENERAL (continued)		
	ASTM C 411 Hot Surface Performance of High-Temperature Thermal Insulation		
	ASTM E 84 Surface Burning Characteristics of Building Materials		
	ANSI B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings		
	NFPA 90A Installation of Air Conditioning and Ventilation Systems		
	AHC-101 Duct Liner Standards		
	ASC-A-700 IC Standard for Adhesives for Duct Liner		
	MF-1 Mechanical Fastener Standard		
1.4	QUALITY ASSURANCE		
	Materials and equipment furnished shall be new and in first class condition.		
	All work to be performed by qualified personnel in a first class craftsman manner. The work shall conform to industry standard practices. The Owner/Engineer reserves the right to direct the removal and replacement of any item which, in his opinion, does not present a neat, workmanlike appearance or does not meet the requirement of the specifications and plans.		
1.5	SUBMITTALS		
	Submit shop drawings, product data, capacity data, certified dimensions, test reports and manufacturer's literature for all materials and equipment. Submittals required but not necessarily limited to:		
	A. Condensing Units		
	B. Air Handlers		
	C. Air Rotation Heater		
	D. Grilles and Registers		
	E. Dampers and Related Operators		



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING

1.0 GENERAL (continued)

F. Ductwork

G. Electric Heaters

H. Refrigerant Piping and Specialties

I. Controls and Wiring Diagrams

J. List of Recommended Spare Parts

1.6 PERMITS, FEES AND CODE REGULATIONS

Contractor shall comply with all National, State and Municipal laws, codes, ordinances and regulations relating to building and public safety.

1.7 DRAWINGS

For purposes of clarity and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, the Contractor shall make use of all data in Contract Documents to verify this information.

Drawings indicate required size and points of termination of pipes and conduits and suggest proper routes to conform to structure, avoid obstructions, and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear. One complete set of drawings issued for this contract shall be maintained exclusively for record purposes by the Contractor, and all significant changes and modifications shall be shown and noted thereon, supplemental drawings or sketches of the control system interconnection wiring and control panel schematic drawings shall be added to the drawing package by the Contractor to provide a complete documentation package of this Heating, Ventilation and Air conditioning System.

Submission of all marked-up "As-Built" drawings shall be made to the Owner/Engineer prior to acceptance of the work.



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING

1.0 GENERAL (continued)

1.8 OPERATING INSTRUCTIONS AND MANUALS

Contractor shall provide copies of operating instructions and maintenance manuals as specified in Purchase Order. Provide product literature and specifications on all equipment, controls, filters, filter media and quantity. Provide framed, under glass, legible control diagrams to be located per Owner/Engineer.

1.9 WARRANTY AND GUARANTEE

All work shall be guaranteed, in writing, to be free of defective work, materials or parts for a period of one (1) year after acceptance, in writing by the Owner/Engineer. Acceptance date will be established when the following requirements are satisfied:

- A. Owner/Engineer accepted Refrigerant Piping Pressure Test with documentation.
- B. Owner/Engineer accepted Piping Evacuation Test with documentation.
- C. Control System complete, function and Owner/Engineer accepted sequence of operating test.
- D. Owner/Engineer accepted TAB report with documentation.
- E. Owner/Engineer accepted "As Built" drawings.

Compressors shall have a five (5) year warranty. Contractor shall repair, revise or replace all defects, leaks, failures or malfunctioning equipment, devices and/or systems at no cost to Owner/Engineer during the guarantee period.

2.0 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Sheet Metal Duct Work

Galvanized steel sheet used in the fabrication of ductwork shall have a galvanized coating of not less than 1.25 oz. per square foot, total for both sides, shall comply with ASTM A 525 and shall be new prime grade, lock forming quality, copper bearing steel sheets.



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING			
2.0 PRODUCTS (continued)			
2.1.2 Duct Liner Insulation			
<p>All rectangular low velocity interior supply air and return air ductwork shall be insulated with 1" thick, 1.5 pcf density internal duct insulation, unless noted otherwise. All materials shall conform to the Duct Liner Materials Standard, AHC-101, of the Thermal Insulation Manufacturers Association. Liner shall meet the requirements of NFPA 90A, ASTM E 84 fire hazard classification for a maximum 25 flame spread rating and 50 smoke developed rating. Insulation shall have a smooth black inner surface which will prevent erosion of fiberglass particles at duct velocities of up to 6000 fpm.</p>			
2.1.3 Refrigerant Piping			
<p>Refrigerant piping shall be: 1/2" and smaller, copper tube, seamless type ACR soft annealed temper, ASTM B 280; 5/8" and larger, copper tube, seamless, type ACR, hard drawn temper, ASTM B 280. All refrigerant piping and components shall be supported and secured with elastomer cushioned type clamps.</p> <p>Piping shall have a slight nitrogen charge and be capped by the manufacturer during shipment. All refrigerant components and tubing shall be kept clean and free of dirt, moisture and contaminants during installation and construction.</p> <p>All fittings shall be wrought copper, solder type, ANSI B16.22. All elbows shall be long radius. For angles other than 90 degrees, use double street ells in lieu of 45 degree ells.</p>			
2.1.4 Temperature Controls System			
<p>Room thermostats for the two air conditioning systems shall be electric, low voltage, and shall provide one stage of cooling in sequence with one stage of electric heating. The thermostat sub-base shall incorporate an "on-off" switch. These shall be equivalent to Honeywell T874A thermostat w/ Q674G sub-base.</p> <p>Air Products RW-UNI-N supply duct mounted ionization type smoke detectors incorporating two sets of alarm contacts and one set of trouble contacts shall be provided for each air conditioning system and for the Air Rotation Heater.</p>			



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING			
2.0	PRODUCTS (continued)		
2.2	EQUIPMENT		
	Equipment shall be as indicated on the drawing. Where a definite item of equipment or type of material is specified, it is not the intention to exclude an "approved equal" item of equipment or material of another manufacturer, however, any proposed substitution for the specified materials and equipment shall be submitted to the Owner/Engineer and written approval obtained prior to substitution.		
2.2.1	Name Plates		
	All equipment shall have standard name plates bearing the manufacturer's name, address, trade name, capacities and catalog number securely affixed to the equipment in a conspicuous place.		
2.2.2	Fire Dampers shall be Underwriters' Laboratories, Inc., classified Fire Dampers with a fire resistance rating as shown on Plan, Air Balance, Inc., or approved equal.		
3.0	EXECUTION		
3.1	INSTALLATION		
3.1.1	All ductwork shall be fabricated and installed in strict accordance with SMACNA - "HVAC Duct Construction Standards - Metal and Flexible".		
	Interior ductwork shall be fabricated for 1" Static Pressure Class, 24 ga. minimum and sealed per Class "B" - SMACNA, unless otherwise noted.		
	Furnish and install access doors in ductwork at all fire/smoke dampers, automatic dampers and other internal operative devices.		
	All flexible connectors shall comply with NFPA 90A.		
	All ductwork shall be securely supported. Hanger rods and trapeze supports shall be hot dipped galvanized.		
	Provide all accessories and hardware to form a complete system.		



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING

3.0 EXECUTION (continued)

All fire dampers shall meet current NFPA and U.L. requirements.

The Contractor shall guarantee that all ductwork is free from objectionable noise or vibration.

3.1.2 Duct Liner Insulation

Duct liner shall be adhered to the sheet metal with adhesives conforming to the Standard for Adhesives for Duct Liner, ASC-A-7001C, of the Adhesives and Sealant Council, Inc. The adhesive shall be classified as Type I. This adhesive shall be nonflammable in the liquid (wet) state and shall pass the edge-burning resistance test.

All portions of the duct designated to receive duct liner shall be covered. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. Duct liner shall be adhered to the sheet metal with 100% coverage of adhesive and mechanical fasteners. All exposed leading edges and all transverse joints shall be coated with adhesive. Duct liner shall be cut to assure overlapped and compressed longitudinal corner joints. Fastener spacing shall be in strict accordance with SMACNA duct liner standards.

Duct liner shall be further secured with fasteners conforming to the Mechanical Fastener Standard, MF-1. Fasteners shall be made of materials having a corrosion resistance capable of withstanding a 96 hour salt spray test when conducted in accordance with ASTM B 117. Fasteners shall further be resistant to the effects of temperatures of 250° F when tested in accordance with ASTM C 411. Fasteners shall be secured to the metal ductwork in a manner that will make a permanent attachment capable of withstanding a 50 pound tensile dead load perpendicular to the sheet metal at room temperature. Mechanical fastener retaining head shall compress the duct liner sufficiently to hold it firmly in place. Retaining head or washer shall be sufficient in size to hold insulation without cutting or tearing the liner. Retaining head shall be not less than 0.75 square inches in area.

3.1.3 Refrigerant Piping

Refrigerant piping joints shall be made with silver solder having a minimum of 15% silver and a melting point of 1200 degrees F minimum.

Liquid lines shall be designed for a maximum of 6 psi pressure drop. A filter dryer and sight glass shall be installed in all liquid lines.



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING			
<p>3.0 EXECUTION (continued)</p> <p>Suction lines shall be designed for a maximum of 2 degrees F drop. All suction lines shall be graded and trapped for proper oil return.</p> <p>Metering devices for evaporators shall be thermostatic thermal expansion valves with external equalizers.</p> <p>Insulate suction lines with 3/4" thick, elastomeric thermal insulation. All insulation exposed to weather shall be protected with aluminum jacket, .015 inch thick.</p> <p>All refrigerant piping shall be pressure tested at 175 psi using slight refrigerant charge for leak detection and balance of dry nitrogen to achieve required pressure. System shall maintain test pressure for 8 hours with no change. Test shall be performed in presence of Owner/Engineer representatives and documented.</p> <p>Upon successful completion of pressure testing, triple evacuation shall be performed with final evacuation to 500 microns. Final evacuation shall maintain standing test for 4 hours at 500 microns, to be witnessed and documented by Owner/Engineer representatives.</p> <p>No systems will be started until requirements of pressure testing and evacuation have been successfully met and documented.</p> <p>All piping to be routed as to not interfere or hamper access for service. Bull heading of tees is not permitted.</p> <p>3.1.4 Temperature Controls System</p> <p>Furnish and install, as hereinafter specified, a complete system of electric/electronic temperature controls. The control system shall be complete in all respects and shall be installed under the supervision of a control subcontractor adjudged by the engineer to be competent to perform this class of work.</p> <p>All control devices and equipment shall carry a one year replacement warranty at no further cost to the Owner.</p>			



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING

3.0 EXECUTION (continued)

Complete control drawings shall be submitted and approved before any field installation is begun. These drawings shall be produced by the temperature controls subcontractor and shall give complete description as well as schematics for each element of the total system. All piping and/or wiring shall be shown with appropriate sizing. A sequence of operations shall accompany each drawing to clearly describe system operation. All control set points shall be shown on the drawings.

All wiring in connection with the temperature control system or its interlocks and all mounting of electric/electronic control devices shall be performed by the controls subcontractor under this division of the specifications. Complete interlock diagrams shall be provided as a part of these specifications.

After completion of the installation, the temperature controls subcontractor shall place the controls system in proper operation and perform any further services incidental to the contract or the warranty.

Each of the two air conditioning systems shall have separate and distinct control systems and shall consist of DX split systems with one stage of cooling and one stage of electric heating. Air Rotation Heater in process area shall be self contained with all controls except for a smoke detector furnished under this section of the specifications.

The air conditioning systems consists of DX split system air units and associated condensing units. Heating and cooling stages shall be cycled automatically in sequence to maintain space temperature.

The air handling units shall be started manually from an "ON-OFF" switch on the thermostat sub-base. The air unit shall run continuously subject to the further supervision of a supply duct mounted smoke detector capable of shutting down the entire system when sensing products of combustion in the supply air stream.

Whenever the fan is operating, the control system is enabled. When the fan is stopped, all cooling is stopped. When enabled the room thermostat shall automatically sequence the heating or cooling to maintain space temperatures.

The Process Area Heater system consists of an Air Rotation Heater complete with all controls except for a smoke detector. Provide an ionization type smoke detector mounted in either the return or supply air stream to sense for products of combustion in that air stream and capable of shutting down the entire system when so sensing. Whenever the fan is operating, the control system is enabled. When the fan is stopped, all cooling and heating is stopped.



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SPECIFICATION FOR HEATING VENTILATING AND AIR CONDITIONING

3.0 EXECUTION (continued)

3.1.5 Incidental Work

Coordinate location and proper dimensions of openings in walls with Architectural and Structural. Cut, patch, and repair walls, floors, etc., where holes have been incorrectly located or sized. Owner/Engineer approval is required before cutting any part where strength or appearance of finished work is involved. Finish in a neat manner to match existing work. After completion of this incidental work, all applicable drawings shall have dimensions, clearance, size and significant references added under "As-Built" drawing mark-up.

3.2 FIELD QUALITY CONTROL

3.2.1 Temperature, Adjusting and Balancing (TAB)

Testing, adjusting and balancing shall be performed in accordance with procedures and techniques outlined in ASHRAE Systems Handbook and SMACNA - HVAC System Testing, Adjusting and Balancing. Final TAB shall be performed in the presence of Owner/Engineer's representatives and documented.

Provide complete certified written TAB and operation report.

3.2.2 Final Calibration

Upon completion of the installation, the calibration of all systems shall be checked and adjusted. Any items found to be out of calibration will be replaced. A letter attesting to the condition of the system shall be provided to the Owner/Engineer upon completion.

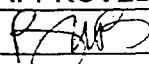

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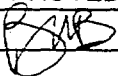


Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00			NO. 16011		
			SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT		
BY WLB	APPROVED 	ISSUE DATE 9/04/96			
<p>THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.</p> <p>FOR CONVENIENCE, THE NATURE OF THE REVISION IS BRIEFLY NOTED UNDER REMARKS. THESE REMARKS ARE NOT A PART OF THE DOCUMENT. THE REVISED PAGES ARE A PART OF THE DOCUMENT AND SHALL BE COMPLIED WITH IN THEIR ENTIRETY</p>					
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					SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
WLE		9/04/96	0	9/04/96		
1.0 GENERAL						
1.1 DESCRIPTION						
<p>This specification shall govern the design, material, fabrication, inspection and testing of all electrical auxiliary equipment supplied by manufacturers under individual equipment specifications as applicable. This general specification covers electrical control panels, stations, wiring, devices and interconnecting hardware. See the "Packaged Equipment Data Sheet" for clarifications and exceptions to this general specification.</p>						
1.2 RELATED SECTIONS						
1.2.1 Section 01300 - Submittals						
Section 01600 - Material and Equipment						
Section 16405 - Specification for Induction Motors						
1.2.2 Motor Data Sheets						
1.2.3 Electrical Data Sheets						
1.3 REFERENCE STANDARDS						
<p>In addition to the requirements of this specification, all electrical equipment shall conform to the latest edition of codes, regulations and standards for the plant location including the following, as applicable:</p>						
ANSI - American National Standards Institutes, Inc.						
NEMA - National Electrical Manufacturer's Association						
IEEE - Institute of Electrical and Electronics Engineers						
ISA - Instrument Society of America						
IEC - International Electrotechnical Commission						
NEC - National Electrical Code						
UL - Underwriters Laboratory						
OSHA - Occupational Safety and Health Act						



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SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT	
1.0	GENERAL (continued)
1.4	QUALITY ASSURANCE
1.4.1	All electrical equipment shall be designed or shall be of a design for heavy duty industrial service. Where unspecified, service factors shall be for continuous operation, 24 hours per day.
1.4.2	Construction materials and equipment supplied shall be of highest quality and free of defects and imperfections. Materials and equipment shall be of recent manufacture, unused, of current standard line relatively safe from obsolescence. Materials and equipment shall be of domestic origin and in accordance with any classification and grade designated.
1.5	SUBMITTALS
1.5.1	All documentation shall be in accordance with Section 01300, Submittals
1.5.2	Manufacturer Data
A.	Manufacturer shall supply with quotation, a complete list of electrical loads on the package. The list shall include the nature of each load, voltage, connected horsepower or kVA, and demand HP or kVA of each load.
B.	Manufacturer shall list horsepower, speed, service factor, enclosure type and NEMA code letter for all motors proposed with the Vendor quotation.
1.5.3	Manufacturer Drawings
A.	Manufacturer shall make electrical layout drawings to include panel elevation, all electrical/instrument junction boxes, and tie points showing location and hub sizes for approval by Jacobs.
B.	Schematics and wiring diagrams shall be furnished by manufacturer for approval by Jacobs for all electrical/instrument systems furnished with the packaged equipment.
C.	Interconnecting wiring diagrams shall be provided by manufacturer showing terminals and identifying numbers for approval by Jacobs.
1.6	AREA CLASSIFICATION
	The area of use may be considered a potential explosive hazard due to vapors or dust, or there may be a corrosive condition to be considered. Each area will be classified with respect to these conditions and the classification shall be stated in the basic equipment specification. All equipment must comply with the NEC requirement for the specified area.



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SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT			
2.0 PRODUCTS			
2.1 General			
2.1.1 Manufacturer shall arrange all electrical equipment in full accordance with requirements of the latest edition of the National Electrical Code. Equipment and wiring methods shall be either explosion-proof or general purpose as specified on specific equipment data sheets.			
2.1.2 All switches shall be readily accessible. Covers on switches terminal boxes, and ducts shall be readily accessible.			
2.1.3 All wiring shall be run in threaded hot dipped galvanized or aluminum conduit with NPT threaded malleable iron or aluminum fittings.			
2.1.4 All instruments furnished by the manufacturer shall be identified with permanently attached non-corrosive stainless steel nameplates.			
2.1.5 All pushbutton stations, lights, handswitches, instrument indicating meters, horns, bells, etc. shall be clearly identified with suitable nameplates. Nameplates shall be non-corrosive stainless steel, sized appropriately for device. Nameplates shall be installed with stainless steel pins or screws.			
2.2 WIRING			
2.2.1 General			
Interconnecting wiring or extension of wiring required to devices and equipment external to the package shall be brought to identified terminal blocks in the panel. Terminal blocks shall be segregated into a minimum of 3 types of signals, (1) power wiring, (2) alarm wiring and (3) instrument wiring.			
2.2.2 Wire Identification			
All wiring shall be marked with an identifying code at each termination and be color coded as follows:			
A.C. Power Supply		-	Black (H) White (N) Green (G)
2.2.3 Power Wiring			
A. Power wire shall be stranded single conductor copper, 14 AWG minimum size, with 600 volt, type THWN/THHN insulation, identified by color and label.			



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SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT

2.0 PRODUCTS (continued)

B. All electrical instruments shall be suitable for operation on 120 volts, single phase, 60 hertz power. The manufacturer shall wire the control panel using three separate types of circuits. One shall be for general instruments and chart drives. The second shall be for alarms only. The third shall be for electronic instruments only.

C. General instruments and chart drives shall be powered by individual receptacles in wire mold and 3-wire #16 AWG rubber covered cords. The grounding conductor of the 3-wire conductor cord shall be bonded securely to the instrument case. Provide 20% spare receptacles for possible instrument revisions or expansions.

2.2.4 Grounding

A. Provide grounding conductors and systems per article 250 of the N.E.C.

B. Provide a separate, insulated green equipment grounding conductor for power circuits. Raceway alone for ground path is not acceptable.

C. Grounding connections shall be made with exothermic welding process or with grounding clamps, connectors, and fittings that are designed for that purpose.

2.2.5 Alarm Wiring

A. Alarm wire shall be stranded single conductor copper, 14 AWG minimum size, with 600 volt, type THWN/THHN insulation, identified by color and label.

B. All switches for alarms furnished with the panel shall be wired directly to alarm terminal blocks within the panel. Care shall be taken to locate switches so that they do not interfere with access to any instrument mounted on front of panel.

C. Common alarm contacts for use by others shall alarm by contact opening.

2.2.6 Instrument Wiring

A. All signal and control wire shall be color coded, shielded duplex, minimum #16 AWG stranded copper, PVC insulated. Signal and control wiring should not be run in the same wireway as power wires. All instrument signals leaving the manufacturer furnished panel for purchaser's use, shall be 4-20 ma isolated. These signals shall be terminated on a clearly marked accessible terminal strip.



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SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT			
2.0 PRODUCTS (continued)			
2.3 Terminations and Junction Boxes			
2.3.1 Manufacturer shall provide terminal strips and junction boxes for all incoming wiring other than thermocouple or special instrument leads. Tag each terminal clearly as to item number and destination. Provide separate terminal for each connection to be made by the field or for connections between common wires including instrument wire shields. Use duplicate terminal designations where there are connections between common wires.			
2.3.2 All wiring shall be terminated with insulated self locking fork lugs except for thermocouple extension wire. Prewired cable shall be terminated in accordance to manufacturer's instructions.			
2.3.3 Electrical terminal strips shall be of the open type with insulating barriers between adjacent terminals. Terminals shall be the bind-screw type rated 600V. A minimum of 20 percent spare terminals shall be provided. Each terminal shall be clearly identified with consecutive numbers.			
2.3.4 All open type devices such as relays, switches, pushbutton, etc. shall be approved for area classification.			
2.3.5 Separate junction boxes shall be provided for each type of wiring; i.e. power, alarm and instrument interconnections. Junction boxes shall be as follows:			
A. NEMA 4X Gasketed - Non-Classified Area			
B. NEMA 4X Gasketed, 7 - Class I Div. 2 Area (where required)			
2.4 WIREWAYS			
2.4.1 Separate wireway system shall be provided for power wiring, alarm wiring, thermocouple wiring, and instrument wiring. The wiring from panel mounted devices shall be enclosed in ducts which shall be mounted in the supporting structure.			
2.4.2 Where wiring must flex, because of connection to a hinged terminal board, care shall be taken to ensure that this wiring can flex freely without danger of mechanical damage.			
2.4.3 Panel wiring shall not interfere with the removal of instrument or electrical switches or interfere with routine maintenance work on panel instruments and switches in place.			



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SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT	
2.0	PRODUCTS (continued)
2.4.4	Wireways shall be provided for thermocouple wiring and shall be installed to provide a wireway from the instrument case to a location at the top of the panel, suitable for extension to field points by others. The ducts for thermocouple wire shall be sized for a maximum of 75% fill.
2.5	Motors All motors shall comply with Specification 16405 for Induction Motors and Motor Data Sheet included with the driven equipment specification.
3.0	EXECUTION
3.1	EXAMINATION Not Used.
3.2	PREPARATION All fabrication shall be performed in a workman like manner. All tolerances, fabrication procedures, equipment components, etc. shall be in accordance with the latest applicable codes and special conditions set forth in the individual equipment specifications' sheets and drawings.
3.3	INSTALLATION
3.3.1	By Others
3.4	QUALITY CONTROL
3.4.1	Except for electronic circuits, wiring at all voltage levels shall be checked for insulation resistance. All circuits shall be checked for continuity. A functional test may be performed, in lieu of the continuity check, before shipping. A functional test consists of simulating the Purchaser's devices with temporary switches, relays, lights, or resistors, and of exercising each circuit to demonstrate proper operation of all devices. Tests shall be witnessed by Jacobs' personnel prior to shipment. Five (5) days advance notice of planned tests shall be given by the Vendor to Jacobs.
3.4.2	All test data shall be recorded in writing and co-signed by the Jacobs' representative who witnessed the test. The manufacturer shall submit test data to the Jacobs' representative within two weeks of test completion.



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SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE EQUIPMENT

3.0 EXECUTION (continued)

3.5 PREPARATION FOR SHIPMENT

3.5.1 Prior to shipment, the manufacturer shall insure that all electrical connections are tight and that circuits are isolated.

3.5.2 Electrical and instrumentation equipment that are subject to damage in transit, shall be removed, tagged and packaged to avoid damage.

3.5.3 Electrical relays shall receive special attention to insure against damages caused by transit.

3.5.4 The supplier will be responsible for the loading and securing of the equipment ready for shipment from his yard.

3.5.5 All loose components shall have temporary closures on all openings.



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JEG JOB NO. 35-K-784-00


NO. 16121

SPECIFICATION FOR
25 kV POWER CABLE

BY	APPROVED	ISSUE DATE
WLB		9/12/96

THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 16121	PAGE 1 OF 5
					SPECIFICATION FOR 25kV POWER CABLE	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
WLE		9/12/96	0	9/12/96		

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 This specification describes the general requirements governing the construction and inspection of 25 kV, 1 or 3 conductor, power cable.

1.1.2 The 25 kV Cable Data Sheet describes specific requirements. Specific requirements on the data sheet shall take precedence over this general specification.

1.1.3 Any conflicts which may arise between this specification, codes, standards, drawings, etc., shall be referred to the Owner/Engineer for resolution.

1.2 RELATED SECTIONS

1.2.1 Section 01300 Submittals

1.2.2 Section 01600 Material and Equipment

1.3 REFERENCE STANDARDS

1.3.1 The 25 kV power cable shall be designed, constructed and tested in accordance with all applicable sections of the latest listed standards and codes. It shall be the Vendor's and/or Manufacturer's responsibility to be, or to become, knowledgeable of the requirements of these Standards and Codes.

The Institute of Electrical/Electronic Engineers (IEEE)

National Electrical Code (NEC)

National Electric Manufacturers Association (NEMA)

Insulated Cable Engineers Association (ICEA)

American Society of Testing Materials (ASTM)

Association of Edison Illuminating Companies (AEIC)

Underwriters Laboratories (UL)

1.3.2 The cable strand screen, insulation, and insulation screen shall meet or exceed electrical and physical requirements of ICEA 5-68-516, AEIC CS6, and UL 1072.



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SPECIFICATION FOR 25 kV POWER CABLE

1.0 GENERAL (continued)

1.4 QUALITY ASSURANCE

1.4.1 The manufacturer is expected to provide proof of cable tests per ICEA and AEIC to include the following: compound, sampling, void and contaminant, insulation resistance, high voltage, and classification under UL vertical flame test as non-propagating.

1.4.2 Cable shall be tested per AEIC No. 6 on individual cut lengths.

1.4.3 Each cable reel length shall be controlled for minus (-) 0% and plus (+) 5% length.

1.5 SUBMITTALS

The following submittal data shall be included with the proposal, in accordance with Section 01300, Submittals.

1.5.1 Descriptive data including physical and electrical characteristics, overall diameter, weight, ampacity, etc., along with cable test data showing prior testing in accordance with ICEA Standards.

1.5.2 Recommended procedures for installing, terminating and splicing of the cable proposed.

1.6 SERVICE REQUIREMENT

1.6.1 The cable shall be suitable for installation in ladder type tray in wet and dry locations, indoors or outdoors (exposed to sunlight), directly buried, or in conduit.

1.6.2 The cable shall be used in a 22.86 kV solidly grounded electrical distribution system.

1.6.3 Cables shall be capable of operating continuously at a conductor temperature of 90°C for normal dry operation, 130°C for emergency overload conditions and 250°C for short circuit conditions.

1.6.4 Cables shall be suitable for installation in a 40°C maximum and a -30°C minimum ambient temperature, at an elevation below 3300 feet.

1.7 SHIPPING, HANDLING AND STORAGE

1.7.1 Cable shall be placed on individual reels as specified on the 25 kV Power Cable Data Sheet. Reels shall be of suitable diameters and shall be of substantial construction to withstand multiple handling in transit.



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SPECIFICATION FOR 25 kV POWER CABLE

1.0 GENERAL (continued)

1.7.2 The cable shall be protected with manufacturer's standard protective lagging on each reel.

1.7.3 Each cable reel shall contain two aluminum tags securely attached, and bearing the item number, length of cable, size of conductor and insulating rating.

1.7.4 Cable ends shall be sealed with shrinkable self-sealing end caps. Pulling eyes shall be installed at the open ends.

2.0 PRODUCTS

2.1 GENERAL

A. Single conductor cable: each conductor shall consist of a copper stranded core, a semi-conductor screen EPR insulation, a semi-conducting screen, copper shield, and a black PVC jacket.

B. Three conductor cable. Each conductor shall consist of a copper stranded core, a semi-conducting screen, EPR insulation, an insulation shielding and a bare copper tape shield. The three circuit conductor plus three ground conductor - one in each of the interstices and fillers shall be enclosed in a flexible aluminum or galvanized steel sheath. An outer jacket of PVC shall protect the sheath.

C. A sequential foot marker tape shall be included within the cable construction, when specified.

D. Conductors shall be individually identified, preferably by stamping the bare copper shielding tape with A, B, or C.

E. Manufacturer's identification shall be printed on marker tape at approximately one foot intervals, or acceptable alternate. The complete identification shall include manufacturer's name, insulation thickness, voltage rating, size of conductors, conductor temperature rating for the insulation, cable trade name or specification number, and the year of manufacturer.

2.2 CONDUCTORS AND GROUND WIRES

A. Conductors shall be uncoated annealed copper in accordance with the requirements of ASTM B-3 and shall have mechanical properties conforming to ICEA S-66-524.

B. The conductors stranding shall be Class B, concentric lay in accordance with ASTM B-8.



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SPECIFICATION FOR 25 KV POWER CABLE

2.0 PRODUCTS (continued)

- C. The cross sectional area of the grounding conductors shall be 45% or more of the cross sectional area of one of the circuit conductors.

2.3 CONDUCTOR STRAND SHIELDING

- A. A semi-conducting shielding compound shall be applied during the extrusion process, directly to the surface of the stranded conductor.
- B. The semi-conducting material shall be compatible with the copper conductor and shall effectively bond to the insulation.
- C. The semi-conducting shielding shall strip clean from the conductor for make-up of terminations and splices.

2.4 INSULATION

- A. The insulating material shall be an ethylene propylene rubber based, thermosetting compound.
- B. The insulation shall be extruded directly over the semi-conducting strand shielding forming a homogenous void free mass.
- C. The insulating thickness shall be minimum 290 mils, 133% insulation level.

2.5 INSULATION SHIELDING

- A. A semi-conducting shielding compound shall be applied by extrusion directly over the surface of the insulation.
- B. The semi-conducting shielding shall adhere tightly to and remain in contact with the insulation.
- C. The semi-conducting shielding shall strip clean from the insulation for make-up of terminations and splices.

2.6 COPPER TAPE SHIELD

Bare copper tape 3 mils minimum shall be applied with a helical lap not less than 10% of its width.



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SPECIFICATION FOR 25 kV POWER CABLE

2.0 PRODUCTS (continued)

2.7 JACKET

2.7.1 The cable shall have an overall sunlight resistant (UV), flame resistant, poly-vinyl chloride jacket.

2.7.2 Jacket shall be mechanically rugged, and have excellent resistance to oil and most chemicals.

2.7.3 Minimum thickness shall be 80 mil.

2.7.4 Jacket shall be UL listed as Type MV-90, in accordance with UL 1072.

3.0 EXECUTION

Not used.



Jacobs Engineering Group, Inc.
Central Region Houston, Texas

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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K-784-00

NO. 16405

SPECIFICATION FOR
INDUCTION MOTORS

BY	APPROVED	ISSUE DATE
WLB	<i>RMB</i>	8/26/96

THIS PAGE IS A RECORD OF ALL REVISIONS OF THE DOCUMENT, EACH TIME THIS DOCUMENT IS CHANGED, ONLY THE NEW OR REVISED PAGES ARE ISSUED.

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 16405	PAGE 1 OF 7
					SPECIFICATION FOR INDUCTION MOTORS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
WLB		8/26/96	0	8/26/96		

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 This specification shall govern the design, material, construction, tests, and inspection of integral horsepower, horizontal and vertical induction motors, single speed, with TEFC and TEFC-XP enclosures in NEMA standard frame sizes.

1.1.2 This specification does not relieve the manufacturer of the responsibility of complying with industry code and standard requirements.

1.1.3 Purchaser shall be advised of any differences between this specification, the data sheets or drawings and shall decide disposition of same.

1.2 RELATED SECTIONS

The Motor Data Sheet for the project shall be considered a part of this specification. Specific requirements are generally stated in the "Motor design data" part of the data sheet.

1.3 REFERENCE STANDARDS (Latest Edition)

The motor shall be in accordance with the latest edition of the following codes and standards which supplement this specification:

NEMA MG-1	Motors and Generators
IEEE Std 112	Standard Test Procedure for Polyphase Induction Motors and Generators

1.4 QUALITY ASSURANCE

Motors shall be factory-tested in accordance with the requirements of NEMA MG 1. Polyphase induction motors shall be factory tested in accordance with IEEE Std 112, Method B. Tests shall consist of routine testing, including measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal protection. Routine tests on wound-rotor induction motors shall include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Routine tests on all motors shall include high-potential tests.



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SPECIFICATION FOR INDUCTION MOTORS

1.0 GENERAL (continued)

1.5 SUBMITTALS

1.5.1 Nameplate Data

1.5.2 Equipment and Performance Data

1.5.3 General Arrangement drawing, with all physical, coupling, and baseplate dimensions.

1.5.4 Manufacturer's Catalog Data.

1.5.5 Manufacturer's Instructions.

1.5.6 Certificates of Compliance.

2.0 PRODUCTS

2.1 DESIGN

2.1.1 Motors shall be designed for continuous duty and operating under conditions shown on the Motor Data Sheet.

2.1.2 Torques

A. Motors shall be NEMA Design B (normal starting torque), except, where the torque characteristics of the driven equipment require special consideration, Design C (high starting torque) shall be used.

B. The motor locked rotor, pull-up and break down torques shall be as specified below with rated voltage and frequency applied to the motor.

Locked Rotor Torque	MG1-12.37
Break Down Torque	MG1-12.38
Pull Up Torque	MG1-12.39

C. Motors shall be suitable for across-the-line starting.



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SPECIFICATION FOR INDUCTION MOTORS

2.0 PRODUCTS (continued)

2.1.3 Insulation and Temperature Rise

The motor shall be random wound coils and Class "F" or better (non-hygroscopic) insulation. The temperature rise, by resistance of the motor windings over a 40°C ambient, shall not exceed the following when the motor is operated at rated load with rated voltage and frequency applied.

Totally Enclosed Fan Cooled	80°C
Encapsulated	85°C

2.1.4 Voltage and Frequency

The rated voltage and frequency of the motor shall be as shown in Motor Data Sheet. The motor shall operate successfully under running condition at rated load with a combined variation in the voltage and frequency up to 10 percent above or below the rated voltage and the rated frequency, provided that the frequency variation does not exceed 5 percent.

2.1.5 Sizing

All motors will be sized so that they will be non-overloading as required by Jacobs' specification for the driven equipment. Unless otherwise specified this requirement will be based on the motor nameplate rating and a service factor of 1.0. Motors for use with abnormal voltage or frequency or other unusual service conditions will be derated in accordance with NEMA.

2.1.6 Single-Phase Motors

In general, fractional horsepower AC motors shall be capacitor start with external overload protection.

Enclosures for single-phase AC, fractional horsepower motors shall be totally enclosed fan cooled.



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SPECIFICATION FOR INDUCTION MOTORS

2.0 PRODUCTS (continued)

2.2 CONSTRUCTION

2.2.1 Frame

The motor frame, end brackets, fan covers and bearing housing shall be of corrosion resistant cast iron. The frame shall have integrally cast supporting feet. For totally enclosed fan cooled motors the frame shall have cast radiating fins. Drain holes shall be provided in the frame to allow drainage of moisture or condensation from the motor. In the TEFC construction the drain holes shall be drilled and tapped for automatic stainless steel breathers and drains. Motors heavier than 120 pounds will be provided with one or more lifting eye bolts or lifting lugs to facilitate handling.

2.2.2 Stator Assembly

A. The stator assembly shall consist of high grade annealed silicon steel sheets, punched as required, and assembled under pressure.

B. Random coils in the stator slots shall be suitably braced and insulated with a Class "F" or better insulation system. Each coil shall be tested electrically between coils and to ground.

C. All insulation components shall be of highest quality materials with a temperature classification per IEEE standards. Motor temperature ratings shall not exceed this insulation limitations for carrying full load continuously in the maximum ambient temperature shown on the Motor Data Sheets.

2.2.3 Rotor and Shaft

The motor shall be carbon steel properly machined and capable of transmitting the torque produced by the motor. The motor punchings of high grade silicon steel shall be securely keyed together and fastened to the rotor shaft. The rotor shall be die cast aluminum with integrally cast fans and dynamically balanced.



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SPECIFICATION FOR INDUCTION MOTORS

2.0 PRODUCTS (continued)

2.2.4 Shaft Seal

Protective rotating shaft shall be provided to minimize entrance of contaminants into bearings on the shaft extension end. The shaft seal shall be made of synthetic rubber or bronze.

2.2.5 Bearings

- A. Grease or oil-lubricated anti-friction shielded ball bearings shall be used. Bearings should be equal or better than the two year minimum AFBMA B-10 life specification under continuous operation at the motor's rated load.
- B. Housings for grease lubricated bearings shall be provided with two plugged openings accessible from the exterior of the motor while in service; one to receive a pressure fitting, the other to serve as a drain and vent during greasing. All horizontal motor bearings shall be grease lubricated.
- C. Oil lubricated bearing housings shall have a reservoir of sufficient depth to serve as a settling chamber for foreign matter, with a drain plug and vents as required, accessible from the exterior of the motor. An oil level sight glass shall be provided with the proper running oil level and motor stopped oil level inscribed on the sight glass and the motor enclosure.

2.2.6 Ventilation

The motor shall be self-ventilated. TEFC and explosion proof motors shall be provided with an externally mounted cooling fan and fan housing. The fan shall be cast bronze if commercially available, otherwise fiberglass reinforced epoxy. Aluminum fans are not acceptable. The bottom ventilating openings of drip proof motors shall be guarded by baffles or by location to prevent the direct entrance of liquids that might be released by a pump seal failure.



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SPECIFICATION FOR INDUCTION MOTORS

2.0 PRODUCTS (continued)

2.2.7 Conduit Box and Leads

Conduit box shall be cast iron with a threaded opening to provide a watertight and rigid connection diagonally split for easy access to the leads. Box shall be designed for rotation in 90 degree increments to receive conduit from any of four (4) directions to facilitate connections. For totally enclosed motors the gasket between the conduit box and yoke shall be a lead positioner. For open drip proof motors a gasket shall be furnished between the diagonally-split halves of the conduit box, and rubber lead positioner shall be furnished between the conduit box and yoke. All leads shall have terminal lugs and be permanently numbered by means of brass ferrules. A 3/8" minimum tapped hole shall be provided for a grounding connection inside each box. On motors above 1.5 horsepower, the conduit box shall be oversized.

2.2.8 Nameplates

A non-corrosive stainless steel nameplate shall be furnished, attached to the motor frame with stainless steel pins or screws. Minimum information set out in NEMA MG1.-10.38 shall be given on the nameplate. Bearing identification shall be provided.

2.2.9 Vertical Motors

- A. Oil lubricated thrust bearings and either grease or oil lubricated radial bearings will be supplied on vertical motors 75 horsepower through 200 horsepower. Grease lubricated top and bottom bearings will be acceptable in the smaller sizes.
- B. Thrust bearings in vertical motors shall be designed to carry any up or down thrust that the pump may impose during the start-up or operation at any capacity including shutoff. Pump vendor's proposal shall indicate thrust at design point and shutoff, life expectancy of bearings at these values, and bearing number and arrangement.
- C. The use of multiple bearings (stacked bearings) in vertical motors is acceptable only as an added safety feature. Regardless of the number of bearings used, the total thrust load shall not exceed the maximum rated capacity for a minimum 10,000 hours of life of a single bearing.



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SPECIFICATION FOR INDUCTION MOTORS

2.0 PRODUCTS (continued)

D. Where applicable, spherical roller bearings may be supplied. In selecting spherical roller bearing motors, the design shall be checked to insure that the total down thrust exceeds the minimum load rating of bearing support springs.

2.3 MODIFICATIONS

2.3.1 Space Heater

A space heater or heaters shall be furnished on 50 horsepower and above motors only and shall be mounted on the motor frame and the leads brought out to a suitable separate terminal box in the motor. The heaters shall be suitable for operation on 120 volts, single phase, 60 Hz and shall be of a non-corrosive material. Surface temperature shall not exceed ignition temperature of 200°C.

2.3.2 Ground Connection

The rear right motor foot (horizontal motor) as viewed from the coupling end or flange end (vertical motor) on the junction box side shall be drilled and tapped for 3/8" - 16 thread bolt.

2.3.3 Motor Efficiency

Vendor shall quote high efficiency motors.

3.0 EXECUTION

(Not used)



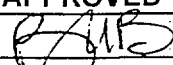
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AFCEE
MMR-PLUME RESPONSE PROJECTS
OTIS ANGB, MA
JEG JOB NO. 35-K-784-00


NO. 16460

SPECIFICATION FOR
PAD MOUNTED TRANSFORMERS

BY	APPROVED	ISSUE DATE
WLB		9/04/96

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AFCEE MMR-PLUME RESPONSE PROJECTS OTIS ANGB, MA JEG JOB NO. 35-K-784-00					NO. 16460	PAGE 1 OF 6
					SPECIFICATION FOR PAD MOUNTED TRANSFORMERS	
BY	APPROVED	ISSUE DATE	REV. NO.	DATE		
WLB		9/04/96	0	9/04/96		

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Transformer shall be of dead-front pad mounted construction.

1.1.2 Transformer shall consist of a transformer tank and two cable terminating compartments, one each for high and low voltage. Transformer tank and compartments shall be assembled as an integral unit for mounting on a pad.

1.1.3 There shall be no exposed screws, bolts, or other fastening devices that are externally removable. There shall be no openings through which foreign objects such as sticks, rods or wires might contact live parts. There shall be means for padlocking compartment door(s). Construction shall limit entry of water (except flood water) into compartment so as not to impair transformer operation.

1.1.4 The Transformer Data Sheet describes specific requirements for transformers. Specific requirements on data sheet shall take precedence over this general specification.

1.2 RELATED SECTIONS

Section 01300 Submittals

Section 01600 Material and Equipment

1.3 REFERENCE STANDARDS

The 3-phase, pad-mounted, dead front transformers and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).

A. ANSI C57.12.26 - 1993, Pad-Mounted Compartmental Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors, High Voltage 34, 500 Grd Y/19, 920 Volts and Below; 2500 KVA and Smaller Requirements

B. ANSI C57.12.70 - 1978 (R1993), Terminals Markings and Connections for Distribution and Power Transformers



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SPECIFICATION FOR PAD MOUNTED TRANSFORMERS	
1.0	GENERAL (continued)
C.	ANSI C119.2
D.	ANSI/IEEE C57.12.00 - 1987, General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
E.	ANSI/IEEE C57.12.80 - 1978 (R1992), Terminology for Power and Distribution Transformers
F.	ANSI/IEEE C57.12.90 - 1993, Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short-circuit Testing of Distribution and Power Transformers
1.4	QUALITY ASSURANCE
1.4.1	Manufacturer shall have specialized in the manufacture and assembly of 3-phase pad-mounted transformers with separable insulated high voltage connectors.
1.4.2	Manufacturer shall provide reference list of users by transformer type, size, and year of sale.
1.5	WARRANTIES
1.5.1	Manufacturer shall warrant equipment to be free from defects in materials and workmanship for 1 year from date of shipment.
1.6	SUBMITTALS
1.6.1	All documentation shall be submitted in accordance with Section 01300, Submittals.
1.6.2	Manufacturer Data
A.	Manufacturer shall provide copies of following documents to Owner for review and evaluation in accordance with general requirements of the purchase order. <ul style="list-style-type: none">• Product Data on specified product;• Shop Drawings on specified product;• Standard Test Data, as required by ANSI/IEEE C57.12.90, by Transformer Serial Number to follow shipment.



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SPECIFICATION FOR PAD MOUNTED TRANSFORMERS

1.0 GENERAL (continued)

B. Manufacturer shall provide copies of installation, operation and maintenance procedures to Owner in accordance with general requirements.

1.7 PROJECT SITE CONDITIONS

Elevation is under 3300 feet (100 meters).

Ambient temperature range is (-) 10°F minimum to (+) 99°F maximum. Design temperature range shall be -30°C to 40°C.

Number of days with ambient temperature above 90°F: 2 days per year.

Average annual snowfall: 37.1 inches

2.0 PRODUCTS

2.1 STANDARD CONSTRUCTION FEATURES

2.1.1 Transformer Ratings

A. Three-phase, 60 Hz

B. Oil-immersed, self-cooled

C. 55/65 degree C rise

D. Primary winding: Delta

E. Secondary winding: Grounded wye with internally grounded neutral

F. Tap changer control shall be for de-energized operation only. It shall be externally operable with a wrench and require at least two operator actions to change taps.

G. Primary taps shall be 2 - 2 1/2 percent taps above, and 2 - 2 1/2 percent taps below



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SPECIFICATION FOR PAD MOUNTED TRANSFORMERS

2.0 PRODUCTS (continued)

2.1.2 Design Features

- A. Full-height, air-filled incoming and outgoing terminal compartments, with hinged doors and separated by a steel barrier, shall be located side-by-side. Incoming compartment shall be on the left, outgoing compartment on the right.
- B. High-voltage compartment shall be accessible only after door to low-voltage compartment has been open.
- C. Compartment hood shall be removable for pulling cables and making connections. Compartment door sills shall be removable to permit rolling or skidding unit into place over conduit studs in foundation.
- D. Compartments hinged doors shall be equipped to latch in open position. High-voltage compartment door shall have a fastening device that is accessible only through low-voltage compartment.
- E. Door hinge assemblies shall be made of corrosion-resistant material. 3/8-inch (minimum) diameter stainless steel hinge pins shall be used.
- F. Both compartment doors shall be able to be locked with a single padlock having a maximum 1/2-inch diameter shackle.
- G. Provide lifting provisions in accordance with ANSI standards, as well as jacking and rolling provisions.
- H. Instruction nameplate shall be located in low-voltage portion of compartment and shall be readable with cables in place. Where the nameplate is mounted on a removable part, manufacture's name and transformer serial number shall be permanently affixed to a non-removable part.
- I. Transformer tank shall be sealed-tank construction with a welded main cover.
- J. A bolted tamper-resistant handhole shall be provided in a tank cover for access to internal connections.



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SPECIFICATION FOR PAD MOUNTED TRANSFORMERS			
2.0 PRODUCTS (continued)			
K. Provisions for tank grounding shall be supplied in both high and low voltage compartments. These provisions shall consist of:			
<ul style="list-style-type: none">For 500 KVA and below, 1/2-13 UNC tapped hole 7/16-inch deep;For 750 KVA and above, two (2), 1/2-13 UNC tapped holes 1/2-inch deep.			
L. Low voltage bushings shall be tinned, spade-type with 9/16-inch holes spaced on 1-3/4-inch centers in accordance with latest revisions of applicable ANSI Standards.			
M. For wye-wye connected units, high and low voltage neutrals shall be connected internally and brought out through a bushing in secondary compartment.			
N. Unless otherwise specified, incoming primary section shall be equipped with six (6) 200-ampere bushing wells for looped primary cable systems or primary selective systems in accordance with ANSI C119.2.			
O. Overcurrent Protection			
Provide oil-immersed, current-limiting and bayonet expulsion fuses coordinated to provide full range protection with expulsion fuses clearing low-current faults and the current-limiting fuses clearing high-current faults up to 50,000 amperes. Fuses shall be removable with a hot stick without disassembly of primary cabinet for external replacement of fuse cartridges. See fuse isolation switch specification below in "P".			
P. Switches			
Provide switch to isolate bayonet fuses. Switch shall be an internal, oil-immersed, gang-operated, two-position (ON-OFF), loadbreak, manually operated switch.			
Radial feed switch(es) shall be an internal, oil-immersed, gang-operated, two-position (ON-OFF), loadbreak, manually operated switch. Switch shall be able to switch transformer full-load current. Switch handle shall be located in primary compartment and shall be hot-stick operable.			



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SPECIFICATION FOR PAD MOUNTED TRANSFORMERS

2.0 PRODUCTS (continued)

2.1.3 Accessories

A. Standard accessories for all units shall include the following:

- 1-inch filling provision;
- 1-inch drain provision; valve and sampler (standard on 750 KVA and above)
- Liquid-level indication
- Dial-type thermometer
- Provisions for vacuum/pressure gauge, 1/4-inch NPT
- Pressure-vacuum gauge
- Lightning arresters consisting of three 18 kV dead front metal oxide varistor elbow arrestors located in the high voltage compartment.

2.1.4 Testing Required

A. No load loss

B. Excitation current at rated voltage

C. Polarity check

D. Ratio check

E. Low frequency dielectric tests at high and low voltage

F. Mechanical leak test

G. Load loss

H. Impedance

I. Production line impulse test

3.0 Execution

Not used.

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JACOBS ENGINEERING GROUP INC.

BUILDING 318, 318 EAST INNER ROAD, OTIS ANG BASE, MA 02542
TELEPHONE (508) 564-5746 • FAX (508) 564-6425

December 8, 1997

Mr. Jim F. Snyder
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road, Box 41
Otis ANG Base, MA 02542-5028

RE: Final Design Report for FS-12 Containment System

Dear Mr. Snyder:

As directed by the Air Force Center for Environmental Excellence, Jacobs Engineering Group Inc. is hereby providing twenty seven bound copies and one unbound copy of the addendum letter and attachments for the *Draft Design Report for FS-12 Containment System*, dated October 1996. The designated number of copies are also being sent to the United States Environmental Protection Agency, the Commonwealth of Massachusetts Department of Environmental Protection, the United States Army National Guard, and other recipients of the original document.

This addendum includes a letter updating what has occurred on the project since the draft report was written, a current well field layout, and the comments/responses/resolutions to the draft document. Please incorporate this addendum document into your Draft Design Report. If you were not on the initial distribution list, individual requests for a full set of the original draft documents will be honored until January 15, 1998.

This addendum letter and attachments now complete the necessary protocols with the regulator and AFCEE concurrence to make the Design Report a final document.

Please feel free to contact Larry Eitel or myself at (508) 564-5746 extension 264, if you have any questions or comments.

Sincerely,


Thomas W. Gorges
Program Manager

Enclosure: Document (28)

JACOBS ENGINEERING GROUP INC.

cc:

EPA:

Paul Marchessault (3)

DEP:

Lynne Doty (1)

Andrea Papadopoulos (3)

Leonard Pinaud (1)

ARNG:

David Hill (c/o IRP) (1)

JoAnn Watson (1)

Larry Lumeh (1)

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Mark Galkowski (1)

FOOT HILL ENGINEERING:

Jim Quinn (1)

JACOBS ENGINEERING GROUP INC.:

Tom Gorges (1)

Tim Forden (1)

George Petersen (1)

Larry Eitel (1)

Bob Lenyk (1)

Karen Wilson (w/o attachment)

File - Document Control (2)

FS-12 PROJECT DESIGN REPORT UPDATE

November 1, 1997

The FS-12 Draft Design Report was prepared to address the design basis to complete the engineering and design of the extraction, treatment, reinjection (ETR) system for the containment of the FS-12 (Fuel Spill 12) plume. This document was issued for comment 20 October 1996 using the most current information and data available at that time. Comments on the document were received, responded to and resolved with the regulators, TRET and JPAT members and other stakeholders. Attachment 1 lists the comments/responses/resolutions.

This update is intended to provide the necessary background to bridge the period between the drafting of the Draft Design Report and the final design used for construction. It will also serve as the vehicle that will close the document review process and result in the Draft Design Report becoming final.

The process unit operation of the system remains the same as described in the Draft Design Report with the groundwater being extracted from the aquifer to the influent tank, pH adjustment, followed by greensand filtration, UV Oxidation, granulated carbon filtration and reinjection to the aquifer. The system's nominal operational rate is 850 gpm as previously reported.

Since the publication of the Draft Design Report in October 1996, several changes have been made to the plume definition and to the extraction and reinjection wellfield as a result of a pre-construction investigation program. Value engineering resulted in changes to the control philosophy for operations.

The Draft Design Report had 30 extraction and 30 reinjection wells in the design. Through additional data collection, modeling, and value engineering the installed wellfield configuration is 25 extraction wells and 23 reinjection wells. The current well configuration is shown in Figure 1, attached. To meet Massachusetts fire regulations the chemical storage tanks, hydrogen peroxide, sodium hydroxide and potassium permanganate were moved outside the treatment building. Fire detection and interfacing with the base wide fire alarm system resulted in additional hardware and software to the instrumentation/control system.

Supporting documents that are referred to within the text of the Draft Design Report have been written. These include the Draft Execution Plan, Performance Monitoring Plan (PME) and the Technical Memorandum - FS-12 Modeling Report.

Upon completion of the as-built drawings, the Piping & Instrumentation Drawings (P&IDs) will be forwarded to each holder of the Draft Design Report for their information. The P&IDs are the final design basis for the operating ETR system.

Memorandum of Resolution
Responses to Comments on the FS-12 Plume Containment System Draft Design Report

Responses to P. Marchessault (USEPA) Comments dated November 5, 1996

General Comments

- I. Although provisions for iron and manganese control are provided at the treatment facility, the potential for iron clogging (or iron bacterial slime growth) within the extraction wells, collection header and influent piping system must be evaluated and presented. Alternatives for addressing this issue, should it become problematic, must be identified now so that provisions for control of management can be incorporated in the system design.

Response: Plugging of the extraction wells and extraction piping with iron deposits and/or biological slime is a significant concern for the FS-12 plume because of the high concentrations of iron present in the concentrated portion of the plume - the wells in the toe of the plume are in areas with a high dissolved oxygen content and thus should have very low iron concentrations. Methods are available to control iron buildup in extraction headers: periodic pigging of the lines, periodic acid washing, magnetic inserts that orient the iron particles to reduce sticking, and the addition of sequestering agents. However, the only known methods of controlling fouling inside the wells are: periodic shock loading with chlorine and/or acid, and oxygenation of the water near the well to precipitate the iron before it reaches the well.

Of the 30 extraction wells at FS-12, only two or three are expected to be installed in areas with a high iron content. To better define the extent of this problem, and to allow the evaluation of alternatives, the following steps are being taken:

- Additional monitoring wells are being sampled to better define the extent of the high iron concentrations.
- Treatability tests are being conducted on drums of water collected from monitoring well GMW-20, which is known to contain high concentrations of iron.
- Vendors with technology for oxygenating groundwater to precipitate iron, are being contacted to better define the costs and limitations of the technology.
- Each extraction well will be sampled for iron during installation to provide early information on the wells that will have high iron concentrations.

Resolution: The EPA provided the following comment regarding Jacob's response: "The findings, conclusions, and recommendations of on-going efforts to evaluate the potential for iron fouling in the collection system must be presented in the FS-12 Operations and Maintenance Manual. If periodic pigging of the lines is considered, the piping design must include cleanouts at appropriate intervals. If chemical dosing or chemical sequestering is considered, impacts on treatment plant performance and/or potential impacts on reinjection water quality must be evaluated. A chemical addition program may necessitate inclusion of additional parameters in the long term downgradient performance monitoring program. All chemical additives must be reviewed and approved prior to implementation."

Jacobs is currently evaluating the control of iron fouling. If chemical treatment is required, it will be presented to the RPM's prior to implementation. Information will be included in either the O&M manual or the startup procedures on actions to take if iron fouling occurs. If this becomes reality after issuance of the O&M manual, information regarding chemical treatment will be provided as an attachment to the manual.

2. A formal submittal process and schedule must be established to address future modifications in the treatment system design and/or locations of extraction and injection wells as additional data and information from on-going field efforts are assimilated.

Response: Future modifications to the treatment system design and/or locations of extraction and injection wells will be addressed at RPM meetings and presented to TRET and JPAT. Only major changes to the design philosophy will be formally submitted.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

Page Specific Comments

- **Comment #1, Page 1-4, §1.2, ¶2:** As a point of clarification, OpTech did not initiate work on a 60 percent design. Work was initiated on a 100 percent design, and the 60 percent design was submitted in January, 1996.

Response: The comment is noted and the text will be modified accordingly.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #2, Page 1-6, §1.2, ¶1:** Since this is the first time that the acronym "ROD" appears, please spell it out.

Response: The test will be modified accordingly.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #3, Page 2-4, §2.1, ¶2 and 3:** The last two paragraphs of this section also appear on the previous page. Please correct as appropriate.

Response: The test will be modified accordingly.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #4, Page 2-29, §2.5.2:** The baseline sampling must be performed early in the program in the event that a change to the design must be made, which would not affect the construction schedule.

Response: As discussed in section 2.5.1, prior to system construction a plume definition data collection program will take place. This effort will include sufficient data collection activities to modify the design, as appropriate. The baseline sampling discussed in section 2.5.2 is intended only to establish baseline contaminant concentrations immediately prior to system operation to evaluate the long term performance of the FS-12 ETR system.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #5, Page 2-55, §2.7.1, ¶2:** The document recognizes that iron and manganese will begin to react with DO in the collection system. Options and recommendations for managing this condition with respect to future clogging must be presented.

Response: See the response for general comment #1.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #6, Page 2-57, Table 2-5:** The Massachusetts MCL for EDB is 0.02 ug/l, while the EPA MCL is 0.05 ug/l. Please correct.

Response: The table will be corrected to reflect that the Massachusetts MCL for EDB is 0.02 µg/l.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #7, Page 2-61, §2.8.3:** The Draft Performance Monitoring Plan must be capable of demonstrating that the containment system is functioning properly at startup (or can be optimized); will not have a significant adverse impact on the ecology of Snake Pond; and will satisfy the overall cleanup objectives. Design of an appropriate performance monitoring program should not be considered a potential design limitation. The hydraulic monitoring elements of the plan must be designed to reflect and monitor the anticipated hydraulic response of the system.

Response: As discussed in the text of Section 2.8.3, details regarding performance monitoring will be submitted under separate cover. An important component of this plan will include hydraulic monitoring. However, as discussed in Section 2.8.3, all stakeholders must recognize that the objective of minimal hydraulic impact will increase the complexity and cost of performance monitoring.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #8, Page 3-7, §3.1.6, ¶3:** Additional details regarding use of NaOCl as a biocide must be provided. Please include the following:

1. Projected dosage for "shock" loading and continuous feed chlorination together with advantages and disadvantages associated with each control strategy.
2. Treatment location/frequency (i.e., will all wells be treated simultaneously and on a regular schedule or will individual wells be treated as necessary).
3. A summary of operational experience associated with use of chlorination to mitigate against potential of clogging of reinjection wells.
4. Criteria to be used to establish dosing schedule and frequency.
5. Options available to monitor residual chlorine compounds within aquifer.

Response: Facilities have been provided to allow the addition of hypochlorite to the water leaving the treatment system, if needed to control generalized biological fouling. Chlorine is not stable in the environment, it reacts with any organic material present and converts to the chloride. So, the chlorine should not migrate any significant distance from the reinjection wells. However, a literature search did not reveal any definitive information on the migration of free chlorine, so the addition of hypochlorite will be used with caution. The following is the response to specific sub-comments:

1. The projected continuous dosage is specified as 2 mg/l free chlorine. This dosage will be used if an increase in pressure drop at the reinjection wells indicates that biological fouling is occurring in all the wells. "Shock" loading if required will be conducted using standard procedures for disinfecting water wells. Shock loading would be conducted at individual wells as part of any required redevelopment of the wells, and would only be conducted if severe fouling occurs at any of the wells. The shock loading would be accompanied by jetting, or some other physical form of forcing the chlorine into the formation, and may also be accompanied by acid washing to dissolve any precipitated inorganics.
2. If continuous injection is used, the hypochlorite will be added to the water leaving the treatment system. If shock loading is required, it will be performed at the individual wells.
3. A literature search did not reveal any experience with the continuous use of chlorine to control fouling in reinjection wells. The 2 mg/l dosage rate was based on standard guidelines for disinfecting potable water and wastewater, plus was based on conversations with Betz, a major supplier of hypochlorite. Shock loading is a common approach to controlling the bacteria growth in water wells. "Groundwater Technology", by Fletcher G. Driscoll provides information on standard shock loading procedures, using free chlorine concentrations in the 500 mg/l to 2000 mg/l range. The book provides examples of satisfactory performance using this shock loading combined with other activities such as "jetting" to agitate the formation, and acid washing to remove any inorganics precipitated by the bacteria.
4. Plugging of the reinjection wells will be monitored by the level in the wells and by the wellhead pressure. The first indication of plugging will be a rise in the level in the wells. The second indication will be an increase in pressure - the system is designed to provide up to 25 psig pressure, at the wells, to help force the water into the formation. Increases in level and/or pressure will be plotted to provide information on when the plugging will begin to impact capacity.
5. If hypochlorite is added on a continuous basis, downstream monitoring wells will be sampled to insure that free chlorine is not migrating from the site. After shock loading, the chlorinated water can be removed from the wells, following the standard procedures for chlorinating wells, so long term monitoring would not be required.

Resolution: The EPA provided the following comment regarding Jacob's response: "Use of a free chlorine concentration of 2 mg/l on a continuous basis appears excessive, possibly by an order of magnitude. Further research and analysis of methods for the control of biofouling in reinjection wells at FS-12 is clearly needed. Given the absence of data regarding continuous injection of chlorine for this purpose, pilot scale testing during system start up should be considered. The suitability of using water treatment and/or wastewater disinfection criteria to establish continuous chlorine dosage in reinjection wells has not been demonstrated. Pilot testing would enable an evaluation of appropriate dosage requirements. Use of a periodic, but intermittent dosing program (i.e., 1 hour per day or 1 day per month) should also be considered."

Jacobs established the design basis of 2 mg/l based on recommendations from Betz Corporation, the supplier of water treating chemicals at Otis, and on the Massachusetts DEP guidelines of maintaining 2 mg/l residual chlorine in drinking water supplies.

Since the original design basis was developed, we have obtained additional information that indicates that 0.2 to 0.5 mg/l may be better concentrations for reinjection water. Sources of this information are:

- "Aquatic Microbiology" by F. A. Skinner and J. M. Shewan (page 247)
- "Troubleshooting - Stopping Iron Bacteria at its Source", in the Canadian Water Well, June 1989 (p8)
- "Controlling Microorganisms in Cooling Water Systems", Chemical Engineering, October 31, 1983 (pp 75-77).

Our program during operation of the reinjection system will be to monitor fouling of the reinjection wells, as indicated by an increase in the water level in the wells. If fouling is occurring, then hypochlorite will be added to the water to maintain a free chlorine concentration in the 0.2 to 0.5 mg/l range. The levels in the wells will continue to be monitored to determine if fouling is still occurring. The monitoring wells will also be sampled to determine if chlorine is migrating off-site. Based on this monitoring, chlorine concentrations may be adjusted, either up or down, to minimize fouling and/or the migration of chlorine.

If addition of chlorine is required to prevent fouling, the procedures and dosages will be presented to the TRET, prior to implementation.

- Comment #9, Page 3.16, §3.2.2, ¶2: The proposed disposal method, monitoring program and location for residuals management disposal must be established and approved. This must include handling and management for residual streams that do not fail TCLP criteria (i.e., how filter backwash will be monitored and disposed).

Response: Sediment from the backwash and treatment operation will be collected in the sedimentation tank and will be analyzed to determine proper disposal. If sediments are hazardous they will be disposed of at a hazardous disposal facility. If sediments are non-hazardous, it will be disposed of at a non-hazardous disposal facility.

Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

General Comments

1. Model Representativeness:

Efforts to date have failed to develop a flow model of the aquifer in the FS-12 area which creates a plume configuration that mirrors the actual contaminant plume.

Initial attempts to recreate the actual plume configuration involved seeding the model with particles representing a release of contaminants at the source. The model was then run for the estimated time it would have taken for the actual plume to have established its current dimensions.

This model run indicated that the bulk of the plume particles discharge to Snake Pond.

Field data does not confirm this situation. In an attempt to better represent field conditions, particles were distributed in the widespread pattern that mimics the actual plume, rather than seeking to recreate the plume by seeding the source, as was done initially. However, when this second version of the model was run, it also indicated that the bulk of the plume particles discharged to Snake Pond.

Therefore, because field data conflicts with the model behavior, predictive runs of the current ETR design may not accurately represent the percent of the plume capture. This is because the ETR system has been designed to capture the modeled plume rather than the actual plume.

The Department recommends using particle tracking rather than numerical modeling techniques to evaluate plume capture in all plume areas.

Response: AFCEE agrees that there are uncertainties in the ability of the FRAC3DVS model to simulate migration of the FS-12 plume. Simulating the transport of contaminants is considerably more complex than groundwater flow modeling. However, including more particle tracking simulations, flow net analysis, or analytical simulations at the present time would not improve the level of confidence in the design basis for the FS-12 ETR system or lend additional insight into the behavior of the FS-12 plume. The primary difficulty in reproducing the behavior of the FS-12 plume is due to uncertainties in the site conceptual model. Some of these uncertainties may never be resolved. For instance the concentration, extent, and volume of the source area, the presence of preferential flow paths in the groundwater flow system, and historical shifts in the location of the groundwater mound near the FS-12 plume, are all factors that could have a pronounced effect on the movement of the FS-12 plume but cannot be quantified with certainty. In addition, none of these factors could be accounted for by performing flow net analysis or analytical simulations.

To the degree possible, AFCEE is attempting to address data gaps before system construction by performing additional pre-design data gap activities, including chemical and hydraulic monitoring to assess interactions between groundwater and Snake Pond, a groundwater screening program to refine the nature and extent of the FS-12 plume, and geotechnical borings to better define the site stratigraphy. As this information becomes available, additional particle tracking runs will be performed and presented to all stakeholders for review and approval. However, it may never be possible to reproduce the current plume configuration due to the unknowns concerning the plume source area and the natural complexities that characterize any groundwater flow system. In addition, it should be recognized that even if the FS-12 model was able to reproduce the FS-12 plume it would not ensure that the design basis for the FS-12 extraction would be more accurate. It is likely that many variations of boundary conditions, and hydraulic parameters could produce the FS-12 plume within the same level of accuracy. Instead, to compensate for uncertainties in the site conceptual model, the FS-

12 ETR system includes flexibility in operating flow rates, and the type and concentration of contaminants that the treatment system can handle.

Resolution: Pursuant to the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the response will be modified as follows:

The FS-12 plume configuration has been updated to mirror the actual contaminant plume, based on the most recent analytical data. Recent modeling simulations are capturing 99.9+% of the plume mass and about 99% of the plume volume. A small number of particles which are being lost to the system are currently being evaluated to determine 3-D details of their particle paths and implications for system performance monitoring and indicators of possible system failure.

We believe that the modeling effort achieves the objectives as outlined in the existing modeling report (ECE, 1996), including maximizing capture while minimizing disturbance of the system (e.g. flux into Snake Pond, disturbance of the J. Braden Thompson Plume). In addition, the basis of design has not been changed significantly from the assumptions discussed at the TRET, JPAT, and other meetings last fall. Based on updated definition of the extent of plume distribution, we are locally modifying the final configuration of the operating ETR system.

In order to provide the MADEP and other interested stakeholders with an appropriate level of understanding of the above information, we have assembled a package of summary information from the modeling runs at FS-12, including:

- Background and history of groundwater modeling at FS-12
- Review of the basis of design and recent field results
- Details of the old model (DSM II) under ambient and pumping conditions, including:
 - * Water level, drawdown and mounding, and particle track maps
 - * Flow nets from representative model layers in map view and cross section
 - * Tabulation of assumptions used in modeling simulations
- Details of the revised stratigraphy under ambient and pumping conditions, including:
 - * Water level, drawdown and mounding, and particle track maps
 - * Flow nets from representative model layers in map view and cross section
 - * Tabulation of assumptions used in modeling simulations
- Maps showing fluxes in/out of Snake Pond

The package will be available on February 28, 1997 for the TRET to review.

2. **Design Effectiveness:**

- a. A complete review and evaluation of the basis for design effectiveness requires that particle track analyses and areal and vertical flow nets must be presented. Neither are available in the report. Please include.
- b. Justification for the selection of the elevations of the screened intervals for the injection and extraction wells should be presented. Specifically, please justify why:
 1. Reinjection and extraction are not at the same depth.
 2. Extraction wells are not screened across the full height of the contaminated aquifer.
 3. Reinjection is proposed along the western flank of the plume but reinjection of treated groundwater along the eastern flank of the plume is not proposed.
- c. Please justify the pumping rates for the axial extraction wells.

Response:

- a. AFCEE is currently performing a variety of data gap activities that will be used to refine the design basis of the FS-12 ETR system, as necessary. Following data gap collection activities, additional particle tracking runs will be presented to all stakeholders. Final particle track analyses and areal and vertical flow nets showing the extent of plume capture will be presented under separate cover for review and approval at that time.
- b.
 1. The toe reinjection well screens are located at the same depth as the extraction well screens. As stated in the Draft Design Report, the north and central reinjection wells are located at a depth predicted by the groundwater flow model that minimized circulation of reinjected water to the extraction wells and enhanced plume capture.
 2. Toe extraction wells are screened across the full thickness of the contaminated portion of the aquifer at the toe of the FS-12 plume. The axial extraction wells are not screened across the full thickness of the FS-12 plume in the more concentrated plume section to maximize capture of the most highly contaminated portion of the plume.
 3. ReInjection wells along the western plume flank are designed to minimize hydraulic impacts to Snake Pond in response to ecological concerns regarding the FS-12 ETR system. Three toe reinjection wells are located along the southeastern flank of the plume. However, additional eastern reinjection wells provide no ecological benefit and are not required to enhance capture of the FS-12 plume.
- c. Pumping rates for the axial extraction wells were iteratively selected by performing multiple modeling runs with the objective of achieving maximum plume capture of the most concentrated portion of the plume. However, it should be recognized that pumping rates for all extraction wells will be adjusted as necessary during performance monitoring to meet project objectives.

Resolution:

- a. Pursuant to the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the response will be modified as follows:

AFCEE is currently performing a variety of data gap activities that will be used to refine the design basis of the FS-12 ETR system, as necessary. Following data gap collection activities, additional particle tracking runs will be presented to all stakeholders. Please note the response to general comment 1, above, including the providing of particle track analyses. The use of areal and vertical flow nets would not be expected to provide additional value to the above package.
- b. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- c. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

3. Data Summary and Evaluation:

The summary and evaluation of the FS-12 data should tabulate and map groundwater analytical results from both the screened hollow stem auger data set as well as from monitoring wells (identify and justify the exclusion of confirmed or suspected false data and flag those data locations that fail to explore the full height of the plume). The Report does not contain such a data summary and evaluation. Instead, the Report refers the reviewer to a report entitled "Plume Containment Design Data Gap Field Work Technical Memorandum: Operational Technologies Corporation." dated

February, 1996. This Technical Memorandum also fails to evaluate the data. Please provide the requested data summary and evaluation.

Response: Data tabulation and an analysis of data quality are beyond the scope of the FS-12 Design Report. As stated previously, data gap activities at FS-12 are currently ongoing. Following completion of data gap activities a summary and evaluation of FS-12 data will be presented under separate cover.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

4. Treatment:

The residence time designed for each carbon bed is 15 minutes. This contact time is based on three carbon vendors' recommendations (7.5 minutes for each bed (page 3-31, last paragraph)) and it is also based on a test conducted in Florida on EDB contaminated groundwater (15 minutes for each bed (page 4-5, paragraph 2)). The Department agrees with 15 minutes of residence time for each carbon bed and 30 minutes for two carbon beds in series or per train. The first carbon bed must be capable of adsorbing all contaminants, the second bed is used for polishing and assurance.

The proposed three parallel carbon train system (two carbon beds per train) satisfies the aforementioned residence time under normal conditions. However, during a carbon bed change, one train will be out of service and the entire flow will be handled by the remaining two trains. Consequently, the residence time for each bed will be reduced to 10 minutes (page 4-5, paragraph 4). This arrangement violates the aforementioned design philosophy and offers very limited assurance. Therefore, the Department recommends that an additional carbon train (two 20,000 pound carbon beds in series) be installed to ensure 15 minutes of residence time for each bed at all times.

Response: We disagree with the need to design the carbon beds for a minimum residence time of 15 minutes based on the following information that was presented in Section 3.3.1 of the Design Report and based on information contained in Appendix B to Volume 1 of the Design Report:

- The pilot tests demonstrated that both benzene and EDB concentrations could be treated to non-detect concentrations using an empty bed contact time of 4.5 minutes.
- Calgon recommended a residence time of 7.5 to 10 minutes.
- A minimum 10 minute residence time was chosen based on the above information and based on additional information listed below.
- To insure a minimum 10 minute residence time during replacement of the carbon, an extra carbon train was specified (a third train). An additional advantage of the third train was information from EDB studies in Florida which indicated that the longer residence time would provide a more efficient utilization of the carbon.

Additional information contained in Appendix B but not summarized in Section 3.3.1 includes:

- More than 1000 homes, with EDB contaminated water in Florida, were provided with activated carbon treatment systems. The carbon treatment systems used had residence times ranging from 2.5 to 5 minutes.
- Carbon treatment systems were installed on nine public water supplies. The residence time in these carbon systems ranged from 5 to 12 minutes.
- The longer residence times in the public water supply systems were used to increase carbon usage efficiency.

As is demonstrated by the above information, a design residence time of as low as 5 minutes will effectively remove the contaminants, but a design residence time of 10 minutes was used instead to be conservative.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

Page Specific Comments

- **Comment #1:** Please provide definition keys for all acronyms and abbreviations.

Response: The text will be modified accordingly.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #2, Page 2-6, Figure 2-2:** Please change EDB to benzene.

Response: The changes will be made to the text.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #3, Page 2-30, Table 2-3:** The Department recommends the baseline sampling plan be expanded. The following wells should be added to the baseline sampling program:

GMW-5
GMW-15
GMW-19
GWM-36
GMW-38
GMW-47
GMW-49
GMW-50
GMW-54 and
GMW-59 (all levels)

Response: As discussed in Section 2.5.2, a more comprehensive round of groundwater sampling will take place prior to system startup. The details of this comprehensive "baseline" groundwater sampling round will be provided in the performance monitoring plan to be provided under separate cover. The DEP recommended wells GMW-5, GMW-15, GMW-19, GMW-36, GMW-38, GMW-47, GMW-49, GMW-50, GMW-54, and GMW-59 will be included in this comprehensive sampling round.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #4, Page 2-35, Paragraph 3:** Ecological monitoring is a component of the system performance monitoring. Please indicate when the Ecological Sampling Plan and schedule will be submitted for review.

Response: The draft Workplan for the Ecological Assessment Associated with Groundwater Plumes and Remedial Activities at MMR was submitted for review on 27 January, 1997. The draft Ecological Sampling and Analysis Plan for FS-12 is scheduled for submission on 21 March, 1997.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #5, Page 2-35, Paragraph 4:** The text stated that "it may be necessary to slightly modify the FS-12 ETR network...to hydraulic impact on the pond...the system will be started slowly to allow monitoring on the pond". Please elaborate on the performance monitoring procedure planned for start-up of the ETR system.

Response: As discussed in the text of Section 2.8.3, details regarding performance monitoring will be submitted under separate cover. A discussion of system startup procedures will be included in the operations and maintenance manuals.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #6, Page 2-40, Paragraph 1:** Since Snake Pond is potentially impacted by the FS-12 ETR system, please add 310 CMR 4.00 (Surface Water Regulations) to AFCEE's list of ARARs.

Response: Note: the correct reference appears to be 314 CMR 4.00, "Massachusetts Surface Water Quality Standards. We agree that 314 CMR 4.00 is an ARAR for the FS-12 Plume Containment Project. The plume containment project meets the requirements of the ARAR as follows:

Based on Figure 31 in 314 CMR 4.00, the waters in Snake Pond are listed as "Inland Waters, Class B". The discharge from the FS-12 treatment system will meet the Class B requirements as follows:

- Hydrogen peroxide is being added to the discharged water to raise the dissolved oxygen content to approximately 8 mg/l, this exceeds the discharge requirement of 5 mg/l for warm water fisheries or the 6 mg/l for cold water fisheries.
- The discharge temperature will be lower than 68°F. The average groundwater temperature is approximately 55°F with an expected 2.2°F temperature rise across the treatment system.
- The discharge water will either be at the pH of the natural water or will be neutralized to between 6.5 and 8.3.
- The treatment system will not add fecal coliform. Instead, the UV/peroxide system being installed will reduce the concentration of any fecal coliform that are present in the extracted groundwater.
- The treated water will pass through filters and thus will be free from floating, suspended, and settleable solids and from oil and grease.
- Iron and manganese will be removed from the water, which will reduce the color and turbidity of the water.
- No compounds which add a taste or odor will be added to the water.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #7, Page 2-45, Paragraph 4:** While AFCEE is expected to meet state permit requirements as performance standards for the discharge of treated groundwater to the ground, a permit is not required.

Response: We agree that a permit is not required but the discharge from the treatment facility must meet the Commonwealth discharge requirements.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #8, Page 2-54, Table:** Please correct a typographical error for contaminant concentration in the "Hot Spot" column.

Response: The concentration of benzene in the hot spot will be changed to 1.167 micrograms/liter.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #9, Page 2-57, Table 2-5:**
 - a. Please provide specific analytical reference (i.e. 502.1, 502.2 or 524.2) for each Contaminant of Concern (COC).
 - b. The concept of a Practical Quantification Limit (PQL) is usually associated with wastewater analysis. Method Detection Limits (MDLs) for various analyses are experimentally determined using various analytical standards prepared with reagent grade water and do not account for the matrix effects routinely encountered in wastewater analysis. For standard drinking water analysis PQLs and MDLs are in most cases the same value because of the absence of matrix effects. If a matrix effect is suspected, a PQL can be determined experimentally utilizing standard addition techniques. Please replace estimated PQLs with MDLs.
 - c. The MDL for EDB using EPA Methods 504 is 0.010 ug/l (ppb). Therefore, the cleanup level for EDB should be below 0.010 ug/l.
 - d. Cleanup Levels for all organic contaminants in groundwater should be non-detect (ND).
 - e. Contract Required Quantification Limits (CRQL) for USEPA contract laboratories have no relevance for the analysis of groundwater to determine compliance with drinking water standards. Please remove the CRQL column.
 - f. Please indicate that the MCLs reflect the more stringent of the Federal or Massachusetts MCLs (MMCLs). For example: the MMCL for EDB is 0.02 ug/l (micrograms per liter), which is more stringent than the Federal MCL of 0.05 ug/l.
 - g. The Cleanup Level for Iron should be changed to 0.07 ug/l.

Response:

- a. The text will be modified to provide specific analytical reference.
- b. The text will be modified as appropriate.
- c. The design base for the treatment of EDB in the extracted groundwater is treatment to non-detect.
- d. The design basis for treatment of all the organic compounds listed in Table 2-5 is treatment to non-detect. However, in other plumes at the site, organic compounds may be present that are non-toxic (high MCLs or no MCLs) and that are not readily amenable to treatment. If non-toxic organic compounds are detected during the evaluation of the other plumes at the facility, treatment levels for those compounds will be determined on a case by case basis.
- e. The text will be modified as appropriate.

- f. The MCL for EDB will be revised, and footnoted, to reflect the lower Massachusetts MCL of 0.02 microgram/l.
- g. Treatment to an iron concentration of 0.07 µg/l is not feasible using the proposed treatment system. Discussions with the vendors of the Greensand filters indicate that it should be possible to remove 90% of the iron, which is the basis for our design basis treatment concentration of 53 µg/l, however there is no requirement for the removal of iron other than the need to reduce the iron concentration as a pretreatment step upstream of the carbon filters. Iron and manganese are both naturally occurring in the groundwater in the region so the only discharge requirement should be the requirements of 314 CMR 5.00 (Groundwater Discharge Permit Program) which list the maximum allowable iron concentration of 300 µg/l and the maximum manganese concentration of 50 µg/l. The cleanup levels for iron and manganese listed in Table 2-5 are typographical errors. The correct cleanup levels for these two compounds should be listed as 300 µg/l and 50 µg/l respectively.

Resolution:

- a. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- b. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- c. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- d. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- e. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- f. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.
- g. As discussed in the February 5, 1997 FS-12 Design Report comment resolution meeting, the clean up level for iron is not 0.07 µg/L, as stated in the comment. There is not a clean up level for iron and manganese in effluent water that is reinjected to the ground. The treated water can be injected at levels equal to the groundwater's naturally occurring background concentrations of iron and manganese.

As stated on pages 3-14 and 3-15 of the design report, a portion of the effluent water will be used in the treatment building (ie. toilets, safety showers, eye wash stations) and must meet potable water standards. This water will be sampled and analyzed to confirm that it is in compliance with the Massachusetts drinking water standards for iron and manganese of 300 ppb and 50 ppb, respectively.

- **Comment #10, Page 3-15, Paragraph 1:** Please add USEPA method 502 or 524 to the first bullet.

Response: The text will be modified as appropriate.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

Responses to D. Hill (Bregman & Company, Inc.) Comments dated November 1, 1996

- **Comment #1, Section 2.4.2 (Well Locations), pg. 2-17, paragraph 2:** Please illustrate the need for additional investigation to determine placement of southern reinjection fence by locating the J.B.T source area on the figures.

Response: Section 2.5.1 provides a discussion of pre-construction data collection activities, including groundwater sampling during extraction/reinjection well installation. Based on a review of available information several source areas may be associated with the J.B.T. plume. However, to clarify, the potential source areas located closest to the reinjection wells will be provided on Figure 2-3.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #2, Section 2.4.3 (Screen Locations), pg. 2-18, paragraph 2:** How do the selected well screen depths minimize recirculation of reinjected water?

Response: To determine the percentage of recirculated water, particle tracking was performed. Based on the modeling efforts, the proposed screen placements minimized the recirculation of treated water.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment#3, Section 2.4.3 (Screen Locations), Figure 2-5, pg. 2-20:** There is no 0.02 ppb contour on this figure.

Response: Isocontours will be added to Figure 2-5.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #4, Section 2.4.6 (Additional Modeling Efforts), pg. 2-22:** Have the hydraulics of recirculating wells (in conjunction with the FS-12 above-ground treatment system) been modeled? It may be worth doing some optimization runs with the model to determine if 100 % capture of the plume could be achieved (possibly even with a smaller number of wells) if water table drawdown/mounding were no longer a constraining factor.

Response: The hydraulics of recirculating wells are being currently evaluated for several other plumes at MMR. If this technology proves promising it may be applied at other sites. During the 60 percent design effort by OpTech, 100 percent capture of the entire FS-12 plume was achieved with much fewer wells. However, the drawdown and mounding was considered unacceptable. The current extraction/reinjection well scenario is based on large number of modeling runs and additional optimization considering property access constraints in most areas is not possible.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #5, Section 2.5.5 (Ecological Data Collection), pg. 2-35, last paragraph:** Please be more specific in terms of how slowly the system could be turned on.

Response: Details regarding system startup will be provided under separate cover in the performance monitoring plan.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #6, Section 2.8.3 (Hydraulic Monitoring), pg. 2-60:** Specifically, how will performance monitoring be complicated by the low pumping rates?

Response: In general, hydraulic monitoring will be complicated because changes in groundwater elevations due to operation of the FS-12 system will be small in comparison to seasonal fluctuations in the groundwater table. However, details regarding performance monitoring will be provided under separate cover in the performance monitoring plan.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #7, Section 3.1.3 (Greensand Filters), pg. 3-3, last paragraph:** Is the system designed such that no more than one of the four Greensand filter units is in the backflushing mode at any given time? If so, will the three filter units remaining in line be sufficient to handle the system flow rate without interruption?

Response: The system is designed so that only one Greensand filter will backwash at one time. During the period when one filter is backwashing, the other three filters have the capacity to handle the entire design flow rate.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #8, Section 3.1.5 (Carbon Adsorption):** How long will the primary carbon adsorber last at the design influent concentrations? How long does backflushing process take and, therefore, what percentage of the time is there only one carbon adsorber in the treatment train?

Response: Calculations indicate that replacement of a carbon bed will be required about five to nine times per year. Carbon replacement takes about three days, including the time required to order a fresh bed of carbon. During the change out period the entire train containing the replacement bed will be removed from service and the two remaining trains have the capacity to treat the entire design basis flows. Since the entire train will be removed from service during the carbon replacement period, there will be no period of time when the system operates with only one carbon bed in a train.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

Responses to J. Dickerman (TRET Ecological Impacts Team) Comments dated November 4, 1996

- **Comment #1, Page 1-8, Sect. 1-2, 2nd bullet, second sentence:** Add total dissolved solids to the list and change "nutrient" to micronutrient".

Response: The text will be modified accordingly.

Resolution:

- **Comment #2, Page 2-32, Sect. 2.5.5, first paragraph, last sentence:** The discrepancy between the predictions of the model cited and the USGS model should be included. The range of estimates from both models should be included throughout this discussion. In terms of estimating potential changes to the physiochemical parameters of Snake Pond, it is more prudent and conservative, from an impacts assessment standpoint, to use the estimate that may indicate a higher level of impact.

Response: The text will be changed to reflect the range of estimates from the models.

Resolution:

- **Comment #3, Page 2-33, Sect. 2.5.5, second paragraph, second, fourth, fifth, and seventh sentences:** [in second sentence] change "17% rainfall" to "14 to 17% rainfall" and add the USGS values so that the ranges are included in the rest of this sentence. [in fourth sentence] add "to 67%" after "approximately 30%." [in fifth sentence] add "0.3 to" before "0.7 (ambient concentration)". [in seventh sentence] add "to 70%" After "Based on 30% and "to 1.4 (degrees) F" after "0.7 (degrees) F".

Response: As stated previously, the text will be changed to reflect the range of estimates from both of the models.

Resolution:

- **Comment #4, Page 2-34, Sect. 2.5.5, first paragraph, second sentence:** delete "and natural buffers". Snake Pond has, for practical purposes, no buffering capacity with an alkalinity at less than 5 mg/L.

Response: The change will be made to the text.

Resolution:

- **Comment #5, Page 2-34, Sect. 2.5.5, second paragraph, second sentence:** Add at a minimum "overall total of" before "inorganic carbon-". The form of the inorganic carbon available in the pond will be substantially changed from the predominantly free dissolved CO₂ (a form preferred by the submerged aquatic photosynthesizers - algae and macrophytes) at pH 6 to a 70% reduction of the free CO₂ form at pH 7 with an equivalent increase in the bicarbonate fraction at the pH 7.

Response: The suggested text change will be made. The remainder of the comment is a statement of fact and requires no comment or change to text.

Resolution:

- **Comment #6, Page 2-34, Section 2.5.5, third paragraph, second sentence:** and the sentence after the word "predicted". Add a sentence something like: "It is likely that the groundwater supplies an important portion of the TOC in the pond system as groundwater comprises around 85% of the total pond water budget and ambient groundwater has about five times more TOC (5 mg/L) than was measured in Snake Pond water in July 1996 (1 mg/L)."

It is NOT likely that biologic activity within Snake Pond dominates the TOC budget in this pond.

Snake Pond TOC was measured at around 1 mg/L in late July while the groundwater ambient values are around 5 mg/L. Also the low alkalinity further supports that there is low productivity in this system, hence it is unlikely that the biotic activity is dominating the pond concentration of TOC, especially in view of the high percentage of groundwater entering this system.

Response: The text will be modified as appropriate.

Resolution: This topic has been discussed on several occasions since the comment response was submitted. Several statements have been determined to be incorrect and, therefore, the text of the design report will not be modified.

The comment states that the ambient groundwater has about five times more TOC (5 mg/L) than was measured in Snake Pond (1 mg/L). The TOC concentration of 5 mg/L was detected in a sample that was obtained from a monitoring well located within the boundaries of the FS-12 plume and therefore does not represent the ambient TOC concentration of the groundwater. The background TOC of the groundwater is actually closer to 0.5 mg/L. Additionally, with the removal of several of the reinjection wells in the vicinity of Snake Pond from the original design basis, it is more likely that the groundwater will comprise 35% to 70% of the total pond water budget, as opposed to 85%.

It is likely that biologic activity within Snake Pond dominates the TOC budget in the pond.

These topics will be addressed in further detail in the draft Ecological Sampling and Analysis Plan for FS-12, which is scheduled for submission on March 21, 1997.

- **Comment #7, Page 2-34, Sect. 2.5.5, fourth paragraph, fourth sentence:** Correct "9%" to "90%".

Response: The text will be modified accordingly.

Resolution:

- **Comment #8, Page 2-35, Sect. 2.5.5, second bullet:** Delete the "Dissolved Inorganic Carbon" bullet. See information in comment test of comment 5. The treatment system, depending on the pH alteration, can have a substantial impact that would contribute to further lowering primary production in this pond system.

Response: The bullet will be changed to "Total Dissolved Inorganic Carbon."

Resolution:

- **Comment #9, Page 3-7, Sect. 3.1.6, third paragraph in Sect. 3.1.6, second sentence:** Would like more details included in text on the dosage, and likely sphere of impact when shocking or continuously feeding the NaOCl biocide.

Response: The current design provides piping connections that will allow the continuous addition of up to 2 mg/l free chlorine, if required, to control generalized fouling in the wells. Chlorine is not

stable in the environment, it tends to react with any organic material present such as bacteria or soil humus. So, the chlorine should not exist very far from the well. A literature search was conducted to determine if information was available on how far the chlorine could migrate. No useful information was found so the current design basis is to add hypochlorite only if a plugging problem occurs that requires control. If the hypochlorite is added, samples will be collected from downgradient monitoring wells to insure that free chlorine is not migrating from the site.

If individual wells lose capacity because of biological plugging, those individual wells can be given "shock loadings" of hypochlorite. Shock loading uses free chlorine concentrations as high as 500 mg/l to 2000 mg/l, frequently combined with re-development of the well and acid washing. If "shock loading" is required it will be performed at individual wells, using standard procedures for disinfecting water wells.

Resolution:

- **Comment #10, Page 3-25, Sect. 3.2.2, last paragraph:** Please update this information here AND where ever else test is appropriate as to the pH requirements from the state with regards to the effluent requirements.

Response: There are no Commonwealth of Massachusetts requirements for treated water that will be reinjected into the subsurface.

Resolution:

DRAFT

GENERAL NOTES

1. THE INFORMATION CONTAINED HEREIN IS THE PROPERTY OF JACOBS ENGINEERING AND CONSTRUCTION, INC. AND IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM, WITHOUT THE WRITTEN PERMISSION OF JACOBS ENGINEERING AND CONSTRUCTION, INC.
2. THE INFORMATION CONTAINED HEREIN IS THE PROPERTY OF JACOBS ENGINEERING AND CONSTRUCTION, INC. AND IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM, WITHOUT THE WRITTEN PERMISSION OF JACOBS ENGINEERING AND CONSTRUCTION, INC.
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LEGEND:

- 90CM0010 EXTRACTION WELL
- 90CM0020 REINJECTION WELL
- 90CM0030 MONITORING WELL

GROUNDWATER ELEVATION CONTOUR

FS-12 PUMP
(CONCENTRATIONS IN $\mu\text{g/l}$)

1. BRADEN THOMPSON PUMP
(5 $\mu\text{g/l}$ TOTAL VOC CONCENTRATION)

NOTE:

Groundwater level measurements collected on November 25, 1996

0 250 500 1000

SCALE IN FEET

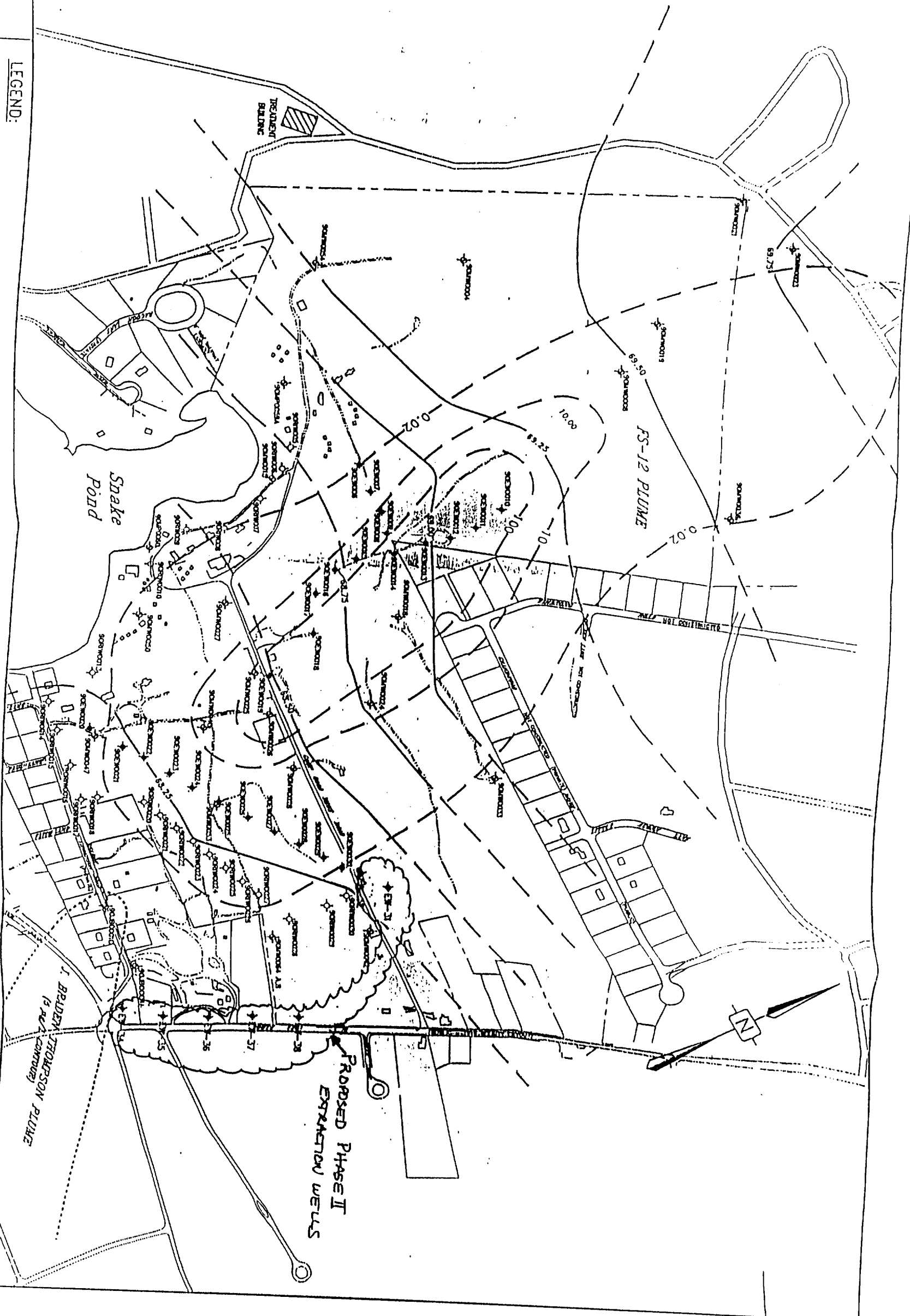
JF

JACOBS ENGINEERING

FS-12 Plume Location
& Extraction/Reinjection
Well Locations

MASSACHUSETTS MILITARY RESERVATION
Cape Cod, Massachusetts

FIGURE 1





DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

27 February 1998

MEMORANDUM FOR AFCEE/ERC

ATTENTION: MS. BARBARA SMITH TOWNSEND

FROM: HQ AFCEE/MMR

322 East Inner Road, Box 41

Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

1. Attached please find the document entitled "Final Design Report for FS-12 Containment System" dated December 1997, which is being provided for information only. Comments are not required.
2. If you have any questions, please call Ed Pesce at (508) 968-4670, extension 4676.

A handwritten signature in black ink, appearing to read "J. Snyder", is positioned above the printed name.

JIM F. SNYDER

Remediation Program Manager

Attachment:

Document (3 copies each/4 volume set)



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

27 February, 1998

MEMORANDUM FOR NGB-PAI-E

ATTENTION: MR. JOHN REINDERS

FROM: HQ AFCEE/MMR

322 E. Inner Road, Box 41

Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

1. Attached please find a copy of the document entitled "Final Design Report for FS-12 Containment System" dated December 1997.
2. If you have any questions, please call me at 508-968-4670, extension 4912.

JIM F. SNYDER

Remediation Program Manager

Attachment:
Document



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

27 February, 1998

MEMORANDUM FOR NGB/JA

ATTENTION: MS. ROSEANN SENDEK

FROM: HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

1. Attached please find a copy of the document entitled "Final Design Report for FS-12 Containment System" dated December 1977.
2. If you have any questions, please call me at 508-968-4670, ext. 4912.

JIM F. SNYDER
Remediation Program Manager

Attachment:
Document



**DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028**

27 February, 1998

**MEMORANDUM FOR SAF/LLP
ATTENTION: MS CHARLOTTE MOYER**

**FROM: HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542-5028**

SUBJECT: Final Report

1. Please be advised that the "Design Report for the FS-12 Containment System" has been issued as a final document.
2. If you have any questions, please call Ed Pesce at 508-968-4670, extension 4676.

A handwritten signature in black ink, appearing to read "JF Snyder", is positioned above the printed name.

**JIM F. SNYDER
Remediation Program Manager**

APPENDIX D



CALGON CARBON CORPORATION

25302 Elm Creek, The Woodlands, TX 77380-2225, USA

Tel: (713) 362-1005 Fax: (713) 367-8198

*Oxidation
Technologies*

Cost Estimate To

Jacobs Engineering

for the supply of a

UV/Oxidation

Groundwater Treatment System

for

**Fuel Spill-12 and Storm Drain-5
Otis AFB, Massachusetts**

SEPTEMBER 13, 1996

Calgon Carbon Oxidation Technologies

Toronto

Pittsburgh

Tucson

I. EXECUTIVE SUMMARY

In response to your inquiry, Calgon Carbon Oxidation Technologies (CCOT) is pleased to offer this cost estimate for a UV/oxidation system to treat groundwater at Otis Air Force Base in Massachusetts. CCOT has prepared this estimate for a system to treat Fuel Spill-12 compounds listed in Table 1 to the required levels at a design flowrate of 1015 gpm. Table 2 represents the compounds and treatment criteria for treatment of Storm Drain-5 at a design rate of 450 gpm.

Table 1 - Design Criteria

Constituent	Influent Conc. (ppb)	Effluent to Carbon (ppb)
Benzene	60	2.2
EDB	8.2	4.2

Table 2 - Design Criteria

Constituent	Influent from GAC.	Effluent
Methylene Chloride	.35 ppb	.2 ppb

Based upon the information provided these treatment trains or hybrids lend themselves to the most flexible, cost effective solution. Other arrangements of the UV/Oxidation equipment (i.e., (2) 3 x 30 kW reactors for FS-12) do not offer significant capital savings and reduce the overall flexibility of the system. Due to this analysis CCOT would only recommend the following treatment options.

Fuel Spill-12- UV/Oxidation followed by carbon polish (As requested this estimate is for the UV/Oxidation system only, it does not include Carbon)

Storm Drain-5- Granulated Activated Carbon (GAC) followed by UV/Oxidation for Methylene Chloride treatment. (As requested this estimate is for the UV/Oxidation system only, it does not include GAC)

Key advantages of the UV/Oxidation system are as follows:

- Destructive Technology
- No Air Emissions
- Designed for Flexibility
- Significant Carbon use reduction

These are the major benefits of using UV/Oxidation versus other technologies. Calgon Carbon Oxidation Technologies would be happy to offer the following assistance in your evaluation process.

- Complete chemical and engineering operational design assistance.
- Visit to a local UV/Oxidation operating system for review.
- References from similar projects.
- Capital cost and Performance guarantee if representative water analysis can be examined.

Calgon Carbon Oxidation Technologies sincerely believes that the systems described are ideally suited for these applications and will provide benefits to meet or exceed your needs and expectations.

We hope to have the opportunity to demonstrate our commitment to technology, quality, and service. For any further information or clarification, please feel free to contact me at

Phone: (713-362-1005)

Fax: (713-367-9637)

Yours sincerely,

CALGON CARBON OXIDATION TECHNOLOGIES
PER:

Al Christopher
Technical Sales Representative

II UV/OXIDATION BACKGROUND

In UV/Oxidation processes, a high powered lamp emits UV radiation into the contaminated water. An oxidizing agent such as hydrogen peroxide can be added which, when activated by the UV light, forms hydroxyl radicals which destroy the toxic organic compounds in groundwater. The photolysis of hydrogen peroxide produces a highly reactive radical, ($\cdot\text{OH}$), which initiates a rapid cascade of oxidation reactions. If allowed to proceed to completion, the end products are carbon dioxide and water. This oxidation can be greatly enhanced, in some cases, by the addition of homogenous catalysts which increase the efficiency of the UV light reactions. For example, the addition of Calgon Carbon Oxidation Technologies proprietary catalyst, ENOX 910, is effective at destroying pollutants in more heavily contaminated groundwater streams.

UV Dose

In the UV oxidation process, a high powered lamp emits UV radiation through a quartz sleeve into the contaminated water. The photons of light activate hydrogen peroxide or a catalyst and generate highly reactive radicals which destroy the organic contaminants. The destruction of organic contaminants is therefore dependent upon the amount of UV light which is applied to the contaminated water.

Calgon Carbon Oxidation Technologies' design parameter for the scale-up of UV oxidation systems is the "UV dose" which is defined as the amount of UV lamp power (in kWh) applied to 1000 gallons of water. This design parameter can be calculated from either flow through or batch situations as follows;

$$\text{UV Dose (Batch)} = \frac{\text{Lamp Size(kW)} \times \text{Time(min)} \times 3785 \text{ (L/1000gal)}}{\text{Volume (L)} \times 60 \text{ (min/hr)}} \quad [1]$$

and

$$\text{UV Dose (Flow)} = \frac{\text{Lamp Size (kW)} \times 1000 \text{ (gal/ 1000gal)}}{\text{Flow Rate (gpm)} \times 60 \text{ (min/h)}} \quad [2]$$

The UV Dose is used to scale-up from a batch design test to a full scale system. For full scale systems using 30 kW lamps, the calculation uses the 27 kW nominal running power instead of the 30 kW maximum power.

Electrical Energy per Order (EE/O)

The destruction of a contaminant by a UV/Oxidation process involves a complex series of chemical reactions. However, experience has shown that this destruction generally follows a first order relationship with the amount of energy input into a unit volume of water (UV Dose). A simple design parameter, which incorporates the UV Dose input to the system and the number of orders of contaminant destruction, can be used to compare and scale-up processes. This design parameter is known as the Electrical Energy per Order or the EE/O and its units are in kWh/1000gal/order.

For example, if it takes 10 kWh of electrical energy to reduce the concentration of a target compound from 10 ppm to 1 ppm (1 order of magnitude or 90% destruction) in 1000 gallons of water, then the EE/O is 10 kWh/1000gal/order for this compound. It will take another 10 kWh/1000gal of UV Dose to reduce the compound from 1 ppm to 0.1 ppm (another 90%).

The EE/O values obtained in a batch system can be applied directly to a full scale flowthrough system. The equation for the EE/O which applies to both batch and flow through situations is:

$$EE/O = \frac{UV \text{ Dose}}{\log (C_i/C_f)} \quad [3]$$

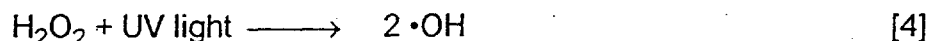
where C_i is the initial concentration and C_f is the final concentration.

In scaling up from bench scale results to a full scale system the EE/O value is calculated. In systems with more than one compound of interest the EE/O for each compound must be determined in the batch testing. The effluent concentration for each compound can then be calculated for the full scale design.

Based on the data provided and Calgon Carbon Oxidation Technologies' experience in treating similar compounds, the controlling compound for Fuel Spill-12 should be Benzene treating from 60 ppb to 2.2 ppb and the EE/O for this should be in the range of 2. For Storm Drain-5 treating Methylene Chloride the EE/O should be 15. These values are what this estimate is based upon.

UV/Oxidation Processes

UV/Peroxide is the most common advanced oxidation process used today. It utilizes the reaction of UV with hydrogen peroxide to generate highly reactive hydroxyl radicals ($\cdot\text{OH}$) as shown below:



This reaction relies on the absorbance of UV light by the hydrogen peroxide molecule. Peroxide absorbs UV light between 200 and 300 nm but absorbs most strongly in the 200 to 240 nm range. Calgon Carbon Oxidation Technologies' medium pressure UV lamps have been designed to give out significantly more UV light in the 200 to 240 nm range than any other UV light source.

The hydroxyl radicals created by the UV light oxidize contaminants in the water to form non-toxic by-products. Hydroxyl radicals react faster with some compounds than they do with others. They react very quickly with chlorinated alkenes, like trichloroethylene (TCE) and c-1,2-dichloroethylene (c-1,2-DCE), because the double bond in these compounds provides an easy target for the hydroxyl radical.

III. SCOPE OF SUPPLY

CALGON CARBON OXIDATION TECHNOLOGIES SUPPLY

Calgon Carbon Oxidation Technologies proposes to supply the following equipment:

Equipment:

Fuel Spill-12 - UV/Oxidation followed by Carbon

- | | |
|-----------|--|
| Three (3) | Pre-piped, pre-wired and fully shop-tested UV/Oxidation skid consisting of 2 (x) 30 kW reactors and power supplies; flanged 4 inch (4") influent and effluent piping connections; system controller (PLC), fully programmed, attached P&ID |
| One (1) | Hydrogen peroxide delivery system |

Storm Drain-5 - Carbon followed by UV/Oxidation

- | | |
|---------|--|
| One (1) | Pre-piped, pre-wired and fully shop-tested UV/Oxidation skid consisting of 4 (x) 30 kW reactors and power supplies; flanged 4 inch (4") influent and effluent piping connections; system controller (PLC), fully programmed, attached P&ID |
| One (1) | Hydrogen peroxide delivery system |

Optional Equipment:

Hydrogen peroxide storage tank with low level switch
Air compressor
Modem
Autodialer
Recycle system to equalization tank for start-up consisting of a automated 3-way valve, wiring and panel-mounted selector switch

SUPPLY BY OTHERS

In order to clarify the scope of Calgon Carbon Oxidation Technologies' supply, it has been assumed for the purposes of this proposal that the following items are supplied by others:

Installation of the system including:

- provision of an industrial indoor environment, 40°F to 95°F, sealed or painted concrete floor
- unloading, placing, leveling, and anchoring equipment
- electrical hook-up
- connecting piping to and from UV/Oxidation system, between UV/Oxidation skids, and to GAC
- Tubing between metering pump(s) and chemical storage tank(s), and between metering pump(s) and UV/Oxidation skid(s)
- electrical wiring and control wiring to/between metering pump(s) UV/Oxidation skid(s), and carbon system
- provision for a lockable electrical disconnect in vicinity of UV/Oxidation system
- provision of utilities including power (480V/120V) and instrument air
- Carbon System

IV. QUOTATION ESTIMATE

Calgon Carbon Oxidation Technologies proposes to supply the UV/Oxidation system as described in this estimate under the commercial terms indicated below:

Fuel Spill-12 - UV/Oxidation only **EQUIPMENT PURCHASE** **\$333,000**

Selling price for three (3) 2 x 30 kW UV/Oxidation Systems as Described
\$333,000

Storm Drain-5 - UV/Oxidation only **EQUIPMENT PURCHASE** **\$189,000**

Selling price for One (1) 4 x 30 kW UV/Oxidation Systems as Described
\$189,000

Prices do not include freight to the job site, taxes, site preparation, or installation.

ESTIMATED OPERATING COST

Fuel Spill-12 - UV/Oxidation only A breakdown of the operating cost per 1000 gallons and per year (350 days) for 1015 gpm are shown below:

	Operating Costs	
	<u>\$/1000 gallons</u>	<u>\$/yr.</u>
Electrical Power (at \$0.06/kWh)	\$0.17	\$29,900
Lamp Replacement	\$0.06	\$10,500
50% Peroxide (at \$0.34/lb, 15 ppm)	\$0.09	\$15,000
Total Operating Cost	\$0.32	\$55,400

Storm Drain-5 - UV/Oxidation only A breakdown of the operating cost per 1000 gallons and per year (350 days) for 450 gpm are shown below:

	Operating Costs	
	<u>\$/1000 gallons</u>	<u>\$/yr.</u>
Electrical Power (at \$0.06/kWh)	\$0.27	\$61,200
Lamp Replacement	\$0.09	\$20,400
50% Peroxide (at \$0.34/lb, 15 ppm)	\$0.09	\$19,300
Total Operating Cost	\$0.45	\$100,900

- Payment Terms: 40% of Purchase Price with Purchase Order
50% on notification of readiness to ship
10% 30 days after delivery
- Delivery: F.O.B. : Markham, Ontario
Taxes : Not included
- Delivery Schedule: 10 - 12 weeks from receipt of down payment
To be confirmed at time of order

Table 2 - Summary of Costs

Treatment Option	Capital Cost	Operating Cost (\$/yr.)
Fuel Spill-12 UV/Oxidation only	\$333,000	\$55,400
Storm Drain-5 UV/Oxidation only	\$189,000	\$100,900

REVISIONS

REV	DATE	BY	APP'D
1	10/01/84	J. D. B.	
2	10/01/84	J. D. B.	
3	10/01/84	J. D. B.	
4	10/01/84	J. D. B.	

NOTES

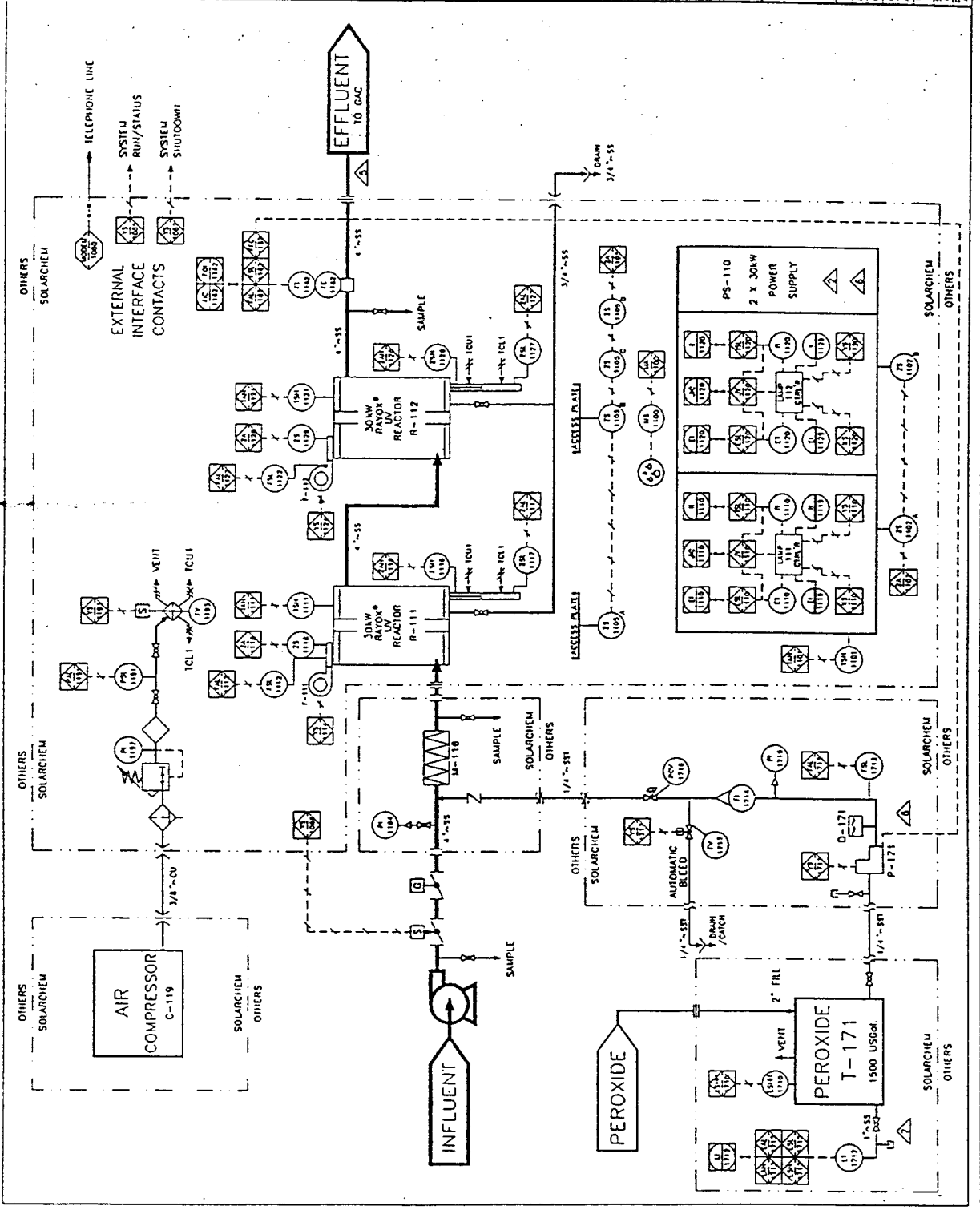
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- FOR DIMENSIONS SEE P&ID.
- FOR DIMENSIONS SEE P&ID.
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FINISH

MATERIAL

REVISIONS

REV	DATE	BY	APP'D
1	10/01/84	J. D. B.	
2	10/01/84	J. D. B.	
3	10/01/84	J. D. B.	
4	10/01/84	J. D. B.	



REVISIONS

REV	DATE	BY	APP'D
1	10/01/84	J. D. B.	
2	10/01/84	J. D. B.	
3	10/01/84	J. D. B.	
4	10/01/84	J. D. B.	

NOTES

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FINISH

MATERIAL

REVISIONS

REV	DATE	BY	APP'D
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2	10/01/84	J. D. B.	
3	10/01/84	J. D. B.	
4	10/01/84	J. D. B.	

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Proposal To

Operational Technologies Corporation

for the supply of a

Groundwater Treatment System

for

**the Massachusetts Military Reservation site
in Cape Cod, Massachusetts**

NO. P540

SEPTEMBER 12, 1995

SOLARCHEM ENVIRONMENTAL SYSTEMS

Los Angeles

Las Vegas

San Francisco (Suisun City)

Toronto (Markham)

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EXECUTIVE SUMMARY

In response to your request, Solarchem is pleased to offer this proposal for a water treatment system to treat contaminated groundwater at the Massachusetts Military Reservation site in Cape Cod, Massachusetts. Solarchem has prepared this proposal for a system to remove ethylene dibromide (EDB) and benzene in the groundwater at a design flowrate of 450 gpm.

The proposed treatment system consists of a hybrid Rayox® UV/Oxidation system followed by a Granular Activated Carbon (GAC) twin vessel train. The Rayox® system will remove 50 % of the EDB and over 99 % of the benzene present in the water, while the GAC system will polish-off the Rayox® effluent to the required discharge limits. The hybrid approach is proposed as the best solution based on testing the actual groundwater in August 1995, and on Solarchem's previous experience in treating similar water streams. Solarchem firmly believes that the proposed system will provide the most cost effective treatment option and stands ready to guarantee its performance.

This treatment approach significantly reduces the treatment system's operating costs as compared to a stand alone GAC system, thus providing the most economical solution. The installation of the Rayox® system upstream of the GAC system would reduce the operating costs of the stand-alone carbon system by as much as 27%, resulting in saving over \$600,000 over the first ten years of operation, assuming a discount rate of 8%. The payback for the additional investment required for the hybrid system installation would be achieved in 1.5 years, with an anticipated internal rate of return of 66%. Furthermore, the reduction of GAC changeout requirements offered by the proposed hybrid system will result into maximum on-stream time.

The principal advantages of selecting Solarchem's proposed treatment system are the following:

1. Fully automated operation
2. Lower operating costs coupled with higher on-line time as compared to that of a stand-alone GAC system
3. Proven lamp quartz cleaning mechanism, which maximizes the system availability while ensuring the integrity of the treatment process
4. High efficiency, high power lamp with the highest spectral output in the region where the listed contaminants and hydrogen peroxide absorb UV light (UV-C region). Solarchem lamps are unique in that they provide the maximum irradiance in the spectral region of the UV band where the hydrogen peroxide absorbs light most strongly, making them the most efficient lamps commercially available for UV/Oxidation
5. The proposed Rayox® based approaches generate no off-gases. This avoids the requirement for an off-gas treatment system and eliminates completely any risk of discharging partially treated VOC's. In addition, the selection of the Rayox® system would eliminate the need for cumbersome air emission permits and their associated compliance testing.

Solarchem's commitment to customer support and to providing customers with the most cost effective and reliable water treatment systems available make it the leader in the field of UV/Oxidation. We feel that the proposed hybrid system offers the greatest system performance, availability and reliability for this particular application.

The selling price for the Rayox® system is \$314,173, which includes the peroxide dosing system, peroxide storage tank and the GAC train. The operating costs including electrical power, replacement lamps, peroxide and GAC replacement are estimated to be \$1.55/1000 gallons, or \$351,049 per year at a flowrate of 450 gpm.

SECTION 1

DESIGN VALIDATION

1.1 DESIGN TEST SUMMARY

This report outlines the design testing results and full scale system design for the Rayox® treatment of groundwater from the Massachusetts Military Reservation site. A design test was performed to demonstrate the effectiveness of Solarchem's Rayox® process for the destruction of benzene and ethylene dibromide (EDB). The objectives of the design test were:

- to confirm the effectiveness of the Rayox® process for reducing the benzene and EDB concentration in the groundwater to the 5 ppb and 0.02 ppb discharge limit respectively, and
- to determine the capital and operating costs to meet the discharge limit for a full scale system treating at a flowrate of 450 gpm.

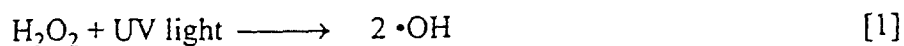
The test work completed on the groundwater streams has confirmed that:

- successful treatment of benzene and EDB can be obtained.
- a Rayox® UV/peroxide process is the recommended option.
- to treat a flowrate of 450 gpm, a Solarchem hybrid system consisting of a 6 x 30 kW Rayox® system followed by duplexed polishing carbon adsorbers would be the optimal treatment.

1.2 UV/OXIDATION THEORY

1.2.1 Advanced Oxidation Processes (AOP)

In advanced oxidation processes, the primary treatment mechanism involves the reaction of UV light with hydrogen peroxide or ozone to generate highly reactive hydroxyl radicals ($\cdot\text{OH}$) as shown below:



The OH radical initiates a rapid cascade of oxidation reactions which, if allowed to proceed to completion, result in carbon dioxide and water as end products. This oxidation can be

greatly enhanced by the addition of homogenous catalysts which increase the efficiency of the UV light reactions.

In some cases, other mechanistic pathways can also be identified such as direct photolysis of the contaminants by UV light or direct reaction of ozone or oxygen radicals with the target contaminants or their intermediate byproducts.

UV Light

The formation of hydroxyl radicals relies on the absorbance of UV light in the range of 200 to 240 nm. In the Rayox® system, this light is provided by high intensity medium pressure mercury vapor lamps. The lamps are housed in quartz tubes and a patented device is used to prevent fouling of the quartz tubes. Solarchem's medium pressure UV lamps have been designed to give out significantly more UV light in the 200 to 240 nm range than any other UV light source. While UV light is needed for the formation of hydroxyl radicals from hydrogen peroxide, it may also serve to break or weaken the chemical bonds of many organic compounds by direct photolysis. This is important for compounds that react slowly with hydroxyl radicals.

Hydrogen Peroxide

Hydrogen peroxide is a commonly used chemical oxidant in advanced oxidation processes. It is normally supplied in concentrations of 35 or 50% in water and is metered into the flow line upstream of the UV lamps. The combination of high intensity UV light and hydrogen peroxide produces an oxidative environment that is effective for the treatment of a broad range of organic compounds.

1.2.2 Design Parameters

UV Dose

In the UV oxidation process, a high powered lamp emits UV radiation through a quartz sleeve into the contaminated water. The photons of light activate hydrogen peroxide, ozone or a catalyst and generate highly reactive radicals which destroy the organic contaminants. The destruction of organic contaminants is therefore dependent upon the amount of UV light which is applied to the contaminated water.

Solarchem's design parameter for the scale-up of UV oxidation systems is the "UV dose" which is defined as the amount of UV lamp power (in kWh) applied to 1000 gallons of water. This design parameter can be calculated from either flow through or batch situations as follows;

$$\text{UV Dose (Batch)} = \frac{\text{Lamp Size(kW)} \times \text{Time(min)} \times 3785 \text{ (L/1000gal)}}{\text{Volume (L)} \times 60 \text{ (min/hr)}}$$

and

$$\text{UV Dose (Flow)} = \frac{\text{Lamp Size (kW)} \times 1000 \text{ (gal/1000gal)}}{\text{Flow Rate (gpm)} \times 60 \text{ (min/h)}}$$

The UV Dose is used to scale-up from a batch design test to a full scale system. For full scale systems using 30 kW lamps, the calculation uses the 27.5 kW nominal running power instead of the 30 kW maximum power.

1.2.3 Electrical Energy per Order (EE/O)

The destruction of a contaminant by a UV/Oxidation process involves a complex series of chemical reactions. However, experience has shown that this destruction generally follows a first order relationship with the amount of energy input into a unit volume of water (UV Dose). A simple design parameter, which incorporates the UV Dose input to the system and the number of orders of contaminant destruction, can be used to compare and scale-up processes. This design parameter is known as the Electrical Energy per Order or the EE/O and its units are in kWh/1000gal/order.

For example, if it takes 10 kWh of electrical energy to reduce the concentration of a target compound from 10 ppm to 1 ppm (1 order of magnitude or 90% destruction) in 1000 gallons of water, then the EE/O is 10 kWh/1000gal/order for this compound. It will take another 10 kWh/1000gal of UV Dose to reduce the compound from 1 ppm to 0.1 ppm (another 90%).

The EE/O values obtained in a batch system can be applied directly to a full scale flowthrough system. The equation for the EE/O which applies to both batch and flow through situations is:

$$\text{EE/O} = \frac{\text{UV Dose}}{\log (C_i/C_f)}, \quad [2]$$

where C_i is the initial concentration and C_f is the final concentration.

In scaling up from pilot scale results to a full scale system the EE/O value is calculated. In systems with more than one compound of interest the EE/O for each compound must be determined in the batch testing. The effluent concentration for each compound can then be calculated for the full scale design.

1.3 DESIGN TEST RESULTS

1.3.1 Pilot Unit

Design testing at Solarchem is performed using a 1 kW *Pilot* unit. This unit consists of a 23 L batch tank, a recycle pump and a 1 kW Rayox® reactor. The 1 kW lamp used has an identical UV output to the 30 kW lamps which are used in a full scale system so that scale-up using the design parameter, UV Dose, is extremely accurate. The unit also has a transmittance controller which is activated by the operator at regular intervals to wipe the quartz sleeve to ensure that the quartz sleeve remains clean throughout the entire run.

1.3.2 Experimental Procedure

For the experiments, 25L of sample water was added to the pilot unit and then recirculated through the reactor at 28 gpm. An initial sample was taken and then additives (i.e. reagents for pH adjustment, if required) were added to the holding tank along with hydrogen peroxide and the lamp was ignited at time = zero. Samples were taken at periodic intervals corresponding to increasing UV doses and were analyzed in-house for benzene and EDB. Results were compared by plotting the concentration of benzene and EDB as a function of UV dose (calculated as total lamp energy per thousand U.S. gallons of water).

1.3.3 Groundwater Characterization

A 55 gallon sample of the groundwater was received on August 10, 1995. The water was stored in a cold room at 39 °F. Analysis of the water gave the following results:

Parameter	Result
Appearance	Cloudy
pH	6.5
TSS, mg/L	<10
COD, mg/L	35
Alkalinity, mg/L	60
Iron, mg/L	< 1
Chloride, mg/L	8.5
Nitrate, mg/L	< 1
Benzene, ppb	445
EDB, ppb	193

The benzene and EDB concentrations were low and not near the anticipated full-scale concentrations of 1000 ppb benzene and 1000 ppb EDB. As a result, the 55 gallon drum was spiked with both benzene and EDB. An analysis for both constituents was carried out after spiking and the results showed 842 ppb benzene and 898 ppb EDB. All test runs were carried out with this water.

The UV absorbance of the water was low. The optical density values at different wavelengths were: 0.42 at 200 nm, 0.26 at 220 nm, 0.23 at 240 nm and 0.22 at 260 nm. In general, a high UV absorbance indicates that non-target water constituents are competing for UV light energy against the target contaminants and hydrogen peroxide, thus decreasing treatment efficiency. The low absorbance levels of the groundwater indicate that there was little interference from competing species.

1.3.4 Sample Analyses

Samples were analyzed by Solarchem for benzene and EDB using a Tekmar 3000 Purge and Trap Concentrator coupled with a Varian 3300 Gas Chromatograph. For all runs, confirmation of the initial benzene concentration was carried out using a Waters HPLC equipped with a 30 cm x 0.46 cm C-18 column with detection using UV spectrophotometry at 225 nm.

1.3.5 Test Results

Solarchem carried out a series of four treatment tests on the groundwater. The test matrix is summarized in Table 1.

Table 1: Test Matrix

Run #	Pre-treatment	Rayox® Process	H ₂ O ₂ ppm	UV Dose kWh/1000 gal
1	None, pH=6.5 as received	UV/H ₂ O ₂	50	0, 3.2, 6.4, 9.5, 12.7, 15.9
2	None pH=6.5 as received	UV/H ₂ O ₂	100	0, 3.2, 6.4, 9.5, 12.7, 15.9
3	pH adjust to 5	UV/H ₂ O ₂	50	0, 3.2, 6.4, 9.5, 12.7, 15.9
4	pH adjust to 5	UV/H ₂ O ₂ Rayox-R	50	0, 3.2, 6.4, 9.5, 12.7, 15.9

The analytical data from the runs is presented in Table 2.

Table 2: Analytical Data from Runs

Run 1: UV/50 ppm peroxide, pH as received

Sample	UV Dose (kWh/1000gal)	Benzene (ppb)	EDB (ppb)
1-0	0	600	898
1-1	3.2	39	654
1-2	6.4	ND	445
1-3	9.5		261
1-4	12.7		181
1-5	15.9		74

ND = Not detected. Detection limit of benzene = 1 ppb

Design Validation

Run 2: UV/100 ppm peroxide, pH as received

Sample	UV Dose (kWh/1000gal)	Benzene (ppb)	EDB (ppb)
2-0	0	682	890
2-1	3.2	59	706
2-2	6.4	8	537
2-3	9.5	ND	358
2-4	12.7		191
2-5	15.9		96

ND = Not detected. Detection limit of benzene = 1 ppb

Run 3: pH adjust to 5, UV/50 ppm peroxide

Sample	UV Dos (kWh/1000)	Benzen (ppb)	EDB (ppb)
3-0	0	410	949
3-1	3.2	17	603
3-2	6.4	2.2	300
3-3	9.5	ND	172
3-4	12.7		59
3-5	15.9		32

ND = Not detected. Detection limit of benzene = 1 ppb

Run 4: pH adjust to 5, UV/50 ppm peroxide, followed by Rayox-R

Sample	UV Dose (kWh/1000gal)	Benzene (ppb)	EDB (ppb)
4-0	0	410	537
4-1	3.2	19.5	316
4-2	6.4	2.9	180
4-3	9.5	ND	76
4-4	12.7		24
4-5	15.9		6.4

ND = Not detected. Detection limit of benzene = 1 ppb

Figure 1 and Figure 2 compares the treatment of the four runs. The fastest rate of treatment is observed for run 4. The slowest rate of treatment is observed for run 2.

1.3.6 Discussion of Results

From Figure 1, the rate of destruction for benzene in all runs were similar as shown by the slopes of the benzene curves. Therefore, the optimal treatment process will be based on the rate of EDB destruction, which was much slower than benzene, but similar within all the runs. From Figure 2, Run 2 had the same rate of EDB destruction as Run 1 (both are UV/peroxide runs only). From an operating cost standpoint, the larger peroxide dose used in Run 2 did not improve treatment efficiency, therefore, Run 1 was more favorable. Operation at pH 5 (Run 3) improved the rate of destruction of EDB.

In Run 4, the water was pH adjusted to 5 with sulphuric acid. The first stage of the treatment used UV/50 ppm peroxide up to 6.4 kWh/1000gal to destroy nearly all the benzene. The residual peroxide was destroyed with sodium sulphite and the water was then pH adjusted to 10 with caustic. Two catalysts, ENOX 710 and ENOX 810, both an inherent part of the Rayox-R treatment process, were dosed into the water at 10 ppm and 40 ppm respectively. The water was subjected to UV light for the remainder of the run. From Figure 1, this run does not show a drastic improvement in EDB destruction. The complexity of this process is not justified by a significant improvement in EDB destruction compared to Run 3 and hence, this run was not considered favorable.

Optimal treatment of benzene and EDB were observed in Runs 1 and 3. In both runs, benzene and EDB destruction rates were similar with Run 3 having a slightly faster rate of EDB destruction at the cost of pH adjustment. In both these runs, the target limit of 5 ppb benzene was reached after a UV dose of 6 kWh/1000gal. The target limit for EDB was not obtained after 15.9 kWh/1000gal. Extrapolation of Run 3 to higher UV doses shows that a UV dose of 36 kWh/1000gal would be required to meet the 0.02 ppb discharge for EDB. At 450 gpm this would require a system size of 35 x 30 kW reactors and would not be cost-effective. As a result of this, Solarchem's hybrid system is proposed. The target limit of 0.02 ppb EDB will be met with a polishing carbon adsorber after the Rayox® system. An economic analysis was carried out to determine the optimal hybrid system configuration based on experimental data from Runs 1 and 3. The results showed that the optimal system from a capital and operating cost standpoint was a 6 x 30 kW Rayox system using 50 ppm peroxide followed by duplexed polishing carbon adsorbers. From an operational and maintenance standpoint, the hybrid system does not have any complexities associated with pH adjustment equipment and the frequency of carbon changeover has been minimized.

1.3.7 Extrapolation of Results

In scaling up from pilot scale results to a full-scale system the EE/O value is calculated. The larger the EE/O the more energy required and hence treatment is less efficient. By comparing EE/O values from each run one can easily see the reduction in electrical power required for treatment as the conditions are varied. By multiplying the EE/O by the number of orders of magnitude of destruction required, the UV dose is obtained.

Design Validation

From Run 1 a UV dose of 3.2 kWh/1000 gallons reduced the benzene concentration from 600 ppb to 39 ppb. The EE/O, using equation [3] is thus calculated as:

$$EE/O = \frac{3.2}{\log(600/39)} = 2.7$$

Using this EE/O value, the full size system is easily scaled to any flowrate or concentration required using equation [2]. For example, at the design influent of 450 gpm and 1000 ppb benzene, the system size to go down to 5 ppb is:

$$UV \text{ Dose} = 2.7 \times \log(1000/5) = 6.2 \text{ kWh/1000 gal}$$

$$kW = \frac{6.2 \text{ (kWh/1000 gal)} \times 450 \text{ (gpm)} \times 60 \text{ (min/h)}}{1000 \text{ (gal/1000 gal)}} = 168 \text{ kW}$$

Thus a total lamp power of 168 kW is required which can be met with a 6 x 30 kW Rayox® system. The EDB concentration in the Rayox® system's effluent will be reduced by 50%. The remaining EDB is removed to below discharge levels by the GAC vessels.

FIGURE 1
Destruction of Benzene in Optech Groundwater

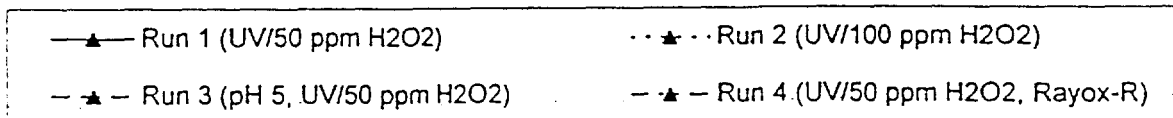
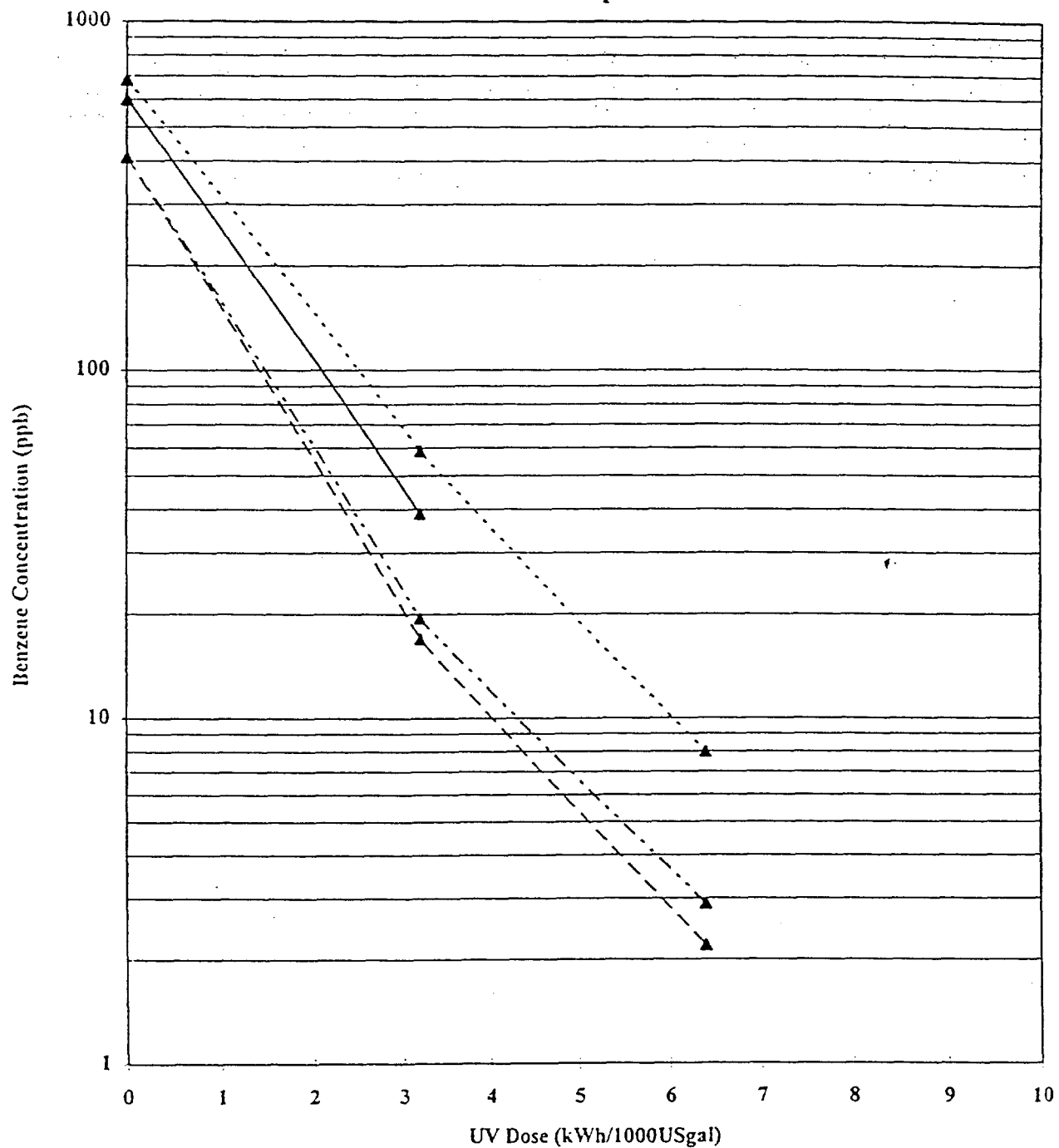
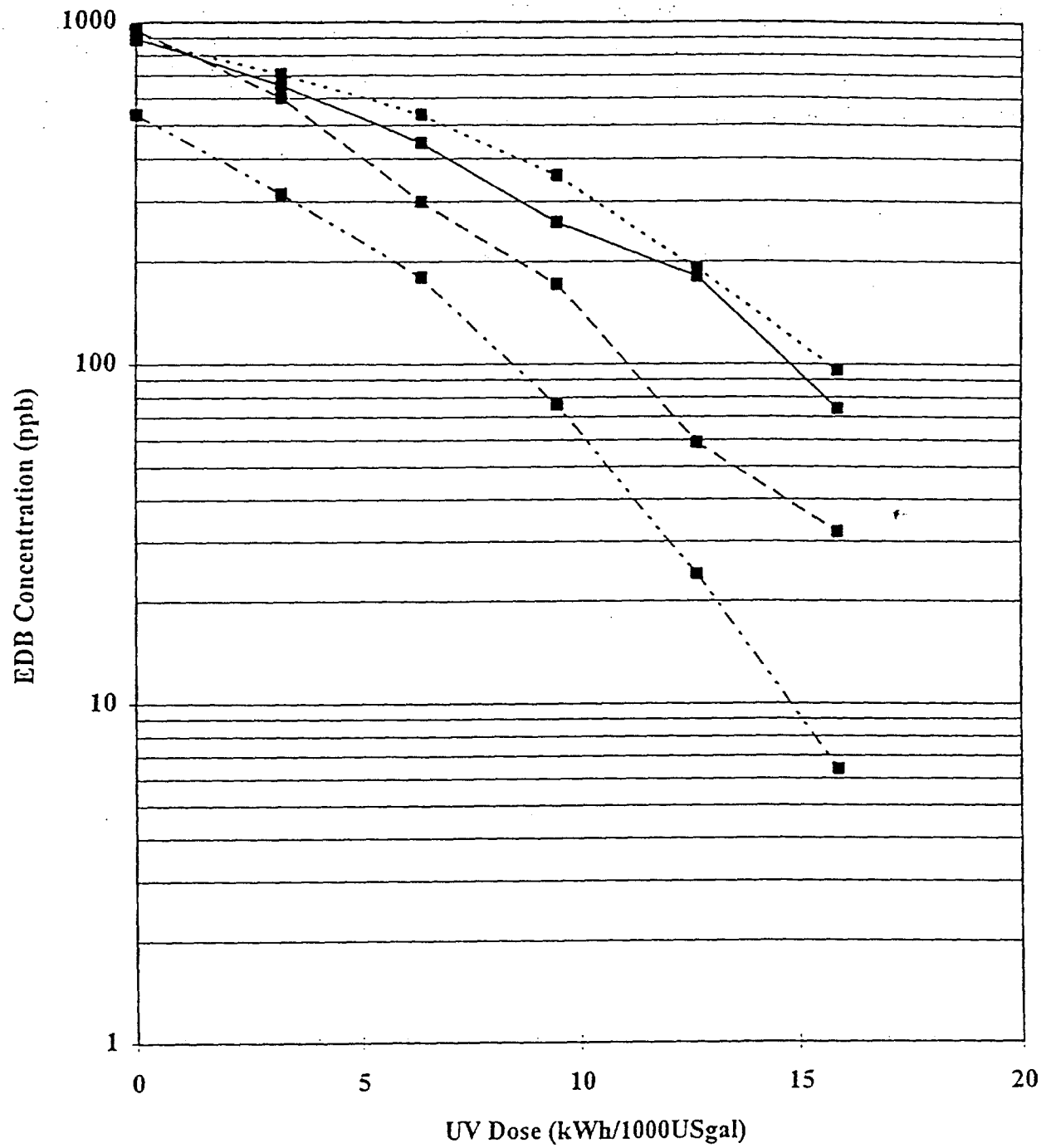


FIGURE 2
Destruction of EDB in Optech Groundwater



—■— Run 1 (UV/50 ppm H ₂ O ₂)	- - ■ - - Run 2 (UV/100 ppm H ₂ O ₂)
- ■ - Run 3 (pH 5, UV/50 ppm H ₂ O ₂)	- ■ - Run 4 (UV/50 ppm H ₂ O ₂ , Rayox-R)

SECTION 2

SYSTEM DESCRIPTION

2.1 PROCESS DESCRIPTION

A flow schematic depicting the operation of the proposed water treatment system is shown in Drawing No. 540-D-000641, enclosed with this proposal. The proposed hybrid groundwater system will accomplish the necessary treatment in two steps, as described below.

UV/Oxidation Step

Groundwater is fed to the treatment system at a flowrate of 450 gpm. Hydrogen peroxide is injected into the influent stream upstream of the Rayox® trains. An in-line static mixer ensures proper peroxide/groundwater mixing prior to entering the Rayox® reactors.

The proposed Rayox® system consists of two trains operating in parallel, each consisting of one skid comprising three (3) 30 kW reactors. The arrangement of three reactors per skid allows for ease of shipping, installation and operation. Inside each reactor, the UV light combines with hydrogen peroxide to form highly reactive oxidizing species which initiate the oxidation process that ultimately destroys the target organic compounds, EDB and benzene in this case, in the groundwater.

The Rayox® reactor is a cylindrical stainless steel vessel at the center of which is a single high powered Solarchem ultraviolet lamp. A quartz sleeve separates the lamp from the water. The quartz sleeve is kept clean automatically by a patented air-actuated quartz cleaner that wipes the surface at regular intervals.

GAC Treatment Step

The effluent stream of the Rayox® treatment system, now only contaminated with EDB and traces of benzene is then fed to the GAC train. The GAC adsorption system utilizes granular activated carbon (GAC) for the removal of dissolved organic compounds from the influent flow. It consists of two vessels installed in parallel. Influent water will enter each vessel at the top and exit through the bottom via an internal collection system designed to evenly collect treated water from the vessel's cross sectional area while preventing the breakthrough of carbon particles.

The entire water treatment system operates under the control of a PLC. The main functions of the PLC software are to control the process, monitor the system status and alert the operator to any fault conditions. The system is fail-safe for operator and equipment safety.

System Description

A keypad with alphanumeric display on the control panel allows the operator to monitor the operating status of the system. Alarm and status messages are displayed on the alphanumeric message annunciator.

2.2 EQUIPMENT SPECIFICATION

Rayox® Reactor System

Rayox® system	: 2 trains, each containing one skid with three reactors
	: Six (6) 30 kW Solarchem UV lamps
	: Fully shielded for protection from UV light
	: Air cooling fan on lamp end
Quartz Cleaner	: Automatic action for cleaning UV reactor quartz sleeve
	: Pneumatic drive
	: 40 micron filter, pressure regulator, oiler
	: Proximity switches to detect operation
	: Adjustable cycle frequency via PLC
Air Compressor	: Reciprocating instrument air compressor for lamp wipers

Hydraulic System

Treatment Capacity	: 450 gallons per minute (225 gpm per train)
Pipe Diameter	: 4" 316L stainless steel, schedule 10 (each parallel train)
Minimum Flowrate	: 50 gallons per minute per train
Materials of Construction	: 316 or 316L stainless steel, quartz, Teflon (wetted) and Viton
Sample Points	: Influent and effluent
Maximum System Pressure	: 50 psig
System Test Pressure	: 100 psig
Pressure Loss @ 450 gpm	: 15 psi (Rayox® system only)
Flow Measurement	: Magnetic flowmeter (each skid)
Flow Totalizer	: Integral digital flow totalizer

Electrical System

Electrical Supply Required :	
Rayox® System	: 480 VAC, 60 Hz, 3 Phase protected supply
Full Load Running Current	: 256 Amps
Air Compressor	: 120 VAC, 60 Hz, 15 Amp outlet

System Description

- | | | |
|----------------------------|---|---|
| High Voltage Rayox® System | : | Housed in a NEMA 1 ventilated and drip-proof enclosure |
| | : | 480 VAC for Lamp Power Supply |
| | : | 6 x 30 kW Lamp Power Supplies |
| | : | 480/120 VAC Transformer |
| | : | Transformers in the high voltage enclosure are capable of rugged long term performance |
| | : | Power factor better than 0.9 at full power |
| Low Voltage Rayox® System | : | 120 VAC for cooling fans, air solenoids, metering pump controls, air compressor and PLC |
| | : | 24 VDC for interlock and input devices |

Physical Specifications

The proposed Rayox® system will be mounted on two (2) skids. Physical specifications for each skid are as follows:

- | | | |
|--------------------------------|---|--|
| Approximate Overall Dimensions | : | 4'W x 9'L x 7.5'H (each skid)
(see attached Drawing No. 000-RD-000254) |
| Required Height Clearance | : | 10.5' |
| Skid Material | : | Structural steel, with acid wash primer, chemical resistant 2 part epoxy paint |
| System Weight (dry) | : | 16,000 lbs (8,000 lbs/skid) |

Chemical Reagents Delivery System

All chemical delivery system components are mounted on a separate stainless steel frame suitable for floor or wall installation. Each skid includes an electrical junction box. Drawings depicting the peroxide, acid and base delivery systems are included. Specifications for the chemical delivery systems are as follows:

- | | | |
|--------------------------|---|---|
| Approximate Dimensions | : | 1'W x 1.5'L x 3'H |
| | : | 64"DIA x 83" H 960 gallon storage tank |
| Hydrogen Peroxide System | : | 960 gallon HDPE (cross linked) storage tank with low level switch |
| | : | 50% Hydrogen Peroxide |
| | : | Estimated requirement 54 gpd |
| | : | Delivery via metering pump |
| | : | Prominent Model Gamma 4 |
| | : | Proportional flow control to influent flowrate |
| | : | In-line spare pump |

System Description

- : Manual override on stroke length/speed
- : Electronic Solid State low flow switch
- : Rotameter
- : Pressure indicator on pump discharge
- : Externally adjustable stainless steel back pressure /check valve
- : Pulsation damper
- : Automatic priming valve
- : Static mixer (6") in process line

GAC System

- | | |
|----------------------------------|---|
| Train Configuration | : Two vessels, skid mounted installed in parallel |
| Model | : Calgon MODEL 8 |
| Skid Dimensions | : 22 ft long x 9.5 ft wide |
| Vessels | : Two (2) |
| Diameter | : 8 ft |
| Overall height | : 16.4 ft |
| Shipping weight | : 16,000 lbs |
| Operating weight | : 92,000 lbs |
| Operating pressure | : 30 psig |
| Design pressure | : 125 psig |
| Parallel operation pressure drop | : 5 psi |
| Construction | : ASME Section VIII, carbon steel construction |
| Underdrain collection system | : Cone shaped, with polypropylene slotted nozzles for water collection and backwash water distribution |
| External Coating | : Epoxy mastic paint system |
| Carbon load per vessel | : 10,000 lbs |
| Carbon type | : Calgon Filtrasorb 300 |
| Accessories | : 6" influent and effluent piping connections
Process and Utility Valves
Differential pressure switch |

Regulatory Compliance

- Certified by CSA, an OSHA accredited Nationally Recognized Testing Laboratory (NRTL)
- Conforms to NFPA National Electric Code (NEC)

SECTION 5

QUOTATION

Solarchem proposes to supply the Rayox® system and to provide commissioning and/or maintenance services, all as described in this proposal under the commercial terms indicated below:

5.1 EQUIPMENT PURCHASE

- Selling price for 6 x 30 kW Rayox® System as Described \$171,016
- Selling price for parallel skid isolation piping (Optional) \$9,535
- Selling price for peroxide delivery system as Described \$5,858
- Selling price for GAC adsorption system as Described \$124,627
- 960 gallon cross-linked HDPE tank for hydrogen peroxide \$3,137
- Air compressor \$546

- Optional Items Priced Separately :
 - Modem \$311
 - Autodialer \$479
 - Flow proportional control on peroxide dosing pump \$503

- Payment Terms: 40% of Purchase Price with Purchase Order
50% on notification of readiness to ship
10% 30 days after delivery

- Delivery: F.O.B. : Markham, Ontario
Taxes : Not included
Customs Clearance : Not included
Extra cost for delivery to site : \$8,000

- Delivery Schedule: 8 - 10 weeks from receipt of down payment
To be confirmed at time of order

- This offer is valid for a period of sixty (60) days from September 12, 1995.

5.2 OPTIONAL SERVICES

Technical Assistance during commissioning of the Water Treatment System \$7,000
(based on 4 mandays on-site, including travel and expenses;
additional mandays at \$550/each plus expenses)

5.3 PERFORMANCE GUARANTEE AND WARRANTY

Performance Guarantee

Solarchem warrants that the Rayox® water decontamination system specified in this proposal will perform in accordance with the treatment requirements specified in Section 3.1, provided it is installed in accordance with Solarchem instructions and provided it is operated and maintained in accordance with the instructions contained in the Solarchem Operation and Maintenance Manual delivered with the Rayox® system.

Should the Rayox® system not achieve the above specified performance and the influent conditions and water chemistry are not materially different than those specified in Section 3.1, Solarchem shall adjust the operating conditions and replace defective system components as necessary to remedy the deficient performance. If necessary, Solarchem shall supply additional Rayox® reactors or other components as necessary to remedy the deficient performance. These additional reactors or other components shall be supplied at no charge to the customer.

Solarchem's obligations under this performance guarantee shall continue throughout the operating life of the Rayox® system, subject only to the condition that Solarchem's liability for replacement components be limited by Solarchem's material and lamp warranties.

Manufacturers Warranty

Material Warranty

Solarchem warrants that, for a period of 12 months from delivery FOB Solarchem's warehouse (Incoterms 1980) of Rayox® to the Buyer, Solarchem will replace or repair non-consumable parts of Rayox® proved to be defective in material or workmanship provided that the Buyer gives prompt written notice of each defect to Solarchem, and provided that the equipment is installed in accordance with Solarchem instructions and operated and maintained in accordance with the instructions contained in the Solarchem Operation and Maintenance Manual delivered with the Rayox® system. Travel time and expenses are charged at cost. Solarchem will be liable for the direct labor and material cost of such repair or replacement by the Buyer only if Solarchem gives prior authorization in writing for the repair or replacement involved.

Quotation

Lamp Warranty

Solarchem lamps are guaranteed to operate at the rated level of contaminant destruction on the following basis, and provided that the service does not exceed 400 starts:

Operating Time

Guaranteed Terms

0 - 100 hours

Lamp replaced at no charge.

101 - 3000 hours

Price prorated by allowing a credit for unused portion of 3000 hours, applied to purchase of the replacement lamp.

There are no representations, warranties or conditions, express or implied, statutory or otherwise, with respect to Rayox® or any part thereof except as expressly provided herein and in the immediately preceding sections.

5.4 TERMS AND CONDITIONS (ATTACHED)

SOLARCHEM ENVIRONMENTAL SYSTEMS
Terms and Conditions of Sale

These terms and conditions of sale shall apply to all equipment, goods or products manufactured distributed or sold by Solarchem Environmental Systems. ("Seller") unless otherwise specified in writing by the Seller and the Purchaser.

1. ACCEPTANCE OF CONDITIONS

- 1.1 The Purchaser, upon receipt of the Seller's acknowledgement of an order, or upon receipt in whole or in part of the shipment sold under an order, or upon payment in whole or in part for the equipment, goods or products sold hereunder, (the Equipment") shall be deemed to have accepted these terms and conditions. Any deletions from, alterations or modifications or additions to the terms and conditions of this order, shall not be binding unless they are expressed in writing and signed by both the Seller and the Purchase's authorized representatives.

2. DELIVERY

- 2.1 Equipment sold hereunder shall be delivered FOB Solarchem's warehouse (Incoterms 1980). Delivery dates specified in any quote are approximate, unless specified as binding. Delivery performance is dependent upon prompt receipt from the Purchaser of all specifications, final approved drawings and any other details essential to the proper execution of the Purchaser's order.
- 2.2 Upon notification of readiness of Equipment by Seller, Equipment shall be delivered promptly to Purchaser. Any delay of Purchaser in accepting delivery of Equipment shall cause storage charges to be charged to Purchaser. Such storage shall be entirely at the Purchaser's risk. Payment terms tied to notification of readiness or delivery, shall apply.
- 2.3 Unless otherwise agreed upon between the parties, Purchaser shall have the sole responsibility of choosing the carrier and routing from Seller's manufacturing facilities to the final destination.

3. FORCE MAJEURE

- 3.1 The seller shall not be liable for delays in the execution of its obligations due to causes beyond its reasonable control including but not limited to acts of God, acts of the Purchaser, fires, strikes, labor disturbances, floods, epidemics, quarantine restrictions, war, insurrection or riot, acts of a civil or military authority, compliance with priority orders or preference ratings issued by any Government, freight embargos, car shortages, wrecks or delays in transportation, unusually severe, weather, or inability to obtain necessary labor, materials or manufacturing facilities or supplies or delays of sub-contractors. In the event of any such delay, the date of shipment will be extended for a minimum of time equal to the period of the delay. The contract of sale will in no event be subject to cancellation by the Purchaser, due either to delay in delivery or to any other cause, without the prior written consent of the Seller. In the case of cancellation, cancellation charges judged adequate by the Seller shall apply.

4. WARRANTIES

- 4.1 The Solarchem Warranty attached to the Quote shall apply.

5. INSURANCE, CHARGES AND PROPER CARE

- 5.1 So long as sums shall remain owing by Purchaser to Seller hereunder, Purchaser shall exercise proper care in the possession and use of the Equipment and shall keep same at all times in good repair and free of all liens, options, taxes, charges, pledges, privileges and encumbrances. Purchaser shall insure Equipment against loss, destruction or theft for the full value of the replacement purchases price of the Equipment.

6. TITLE AND RISK

- 6.1 The title to and property in the Equipment sold hereunder and any substitutions or additions thereto and the right to possession thereof, whether attached to realty or otherwise, shall pass from the Seller to the Purchaser when the full purchase price of the Equipment has been paid. Upon failure to make any payment as herein provided, the whole purchase price and any note of security given on account therefor shall forthwith become due and payable and the Seller may immediately enter the premises where the Equipment is located and take possession of and remove the same as its personal property, and may retain any or all partial payments already received as a rental charge for the use of the Equipment without affecting any further or other claims which Seller may have against the Purchaser.
- 6.2 Equipment sold hereunder shall be at the Purchaser's risk on delivery to it as specified in Article 2 above, and the loss or destruction of all or part of said Equipment shall not release Purchaser from any obligations of payment hereunder.

7. LIMITATION OF LIABILITY

- 7.1 In no event whatsoever shall the Seller be liable for indirect, special or consequential damages for the failure to execute any of its obligations related to the sale of the Equipment. The Seller's liability on any other claim for loss or liability arising out of the sale of the Equipment (including but not limited to, loss or liability arising from breach of contract or tort) shall in no case exceed the net UNIT PRICE exclusive of any taxes, duties, transportation costs, etc. of such Equipment or part thereof involved in a claim.

8. PRICES AND PAYMENT TERMS

- 8.1 Prices are valid thirty (30) days from date of quotation by Seller. Price adjustment clauses, if applicable, will be included as part of these Terms and Conditions, in an Appendix thereto.
- 8.2 All prices are Ex Works Seller's plant unless otherwise specified in writing by Seller. Prices quoted do not include federal, state, local or any other taxes, charges, levies and duties, and if same are applicable these shall be promptly paid by the Purchaser.
- 8.3 In cases where Seller's price includes taxes, charges, levies and duties, in the event of any changes in any taxes charges, levies or duties, imposed under any federal, municipal or local legislation or authority, after the date of submitting of Seller's tender or quotation and applicable to Equipment sold hereunder, the Seller's sale price shall be adjusted to reflect such increases or decreases.
- 8.4 Seller reserves the right to adjust prices on any order for any alterations or changes authorized by the Purchaser subsequent to acceptance of the order.

8. PRICES AND PAYMENT TERMS (Cont'd)

8.5 All prices are in Dollars as specified in the quotation.

8.6 Payment shall be made directly to Seller's office in accordance with the conditions stated in the order. Unless otherwise specified, payment shall be as follows: 40% with purchase order; 50% upon shipment; 10% holdback for up to 30 days after delivery of equipment. Any late payment shall bear interest at the rate set by the Seller from time to time which is one percent (1%) per month, twelve percent per annum (12%), at the date of issue, calculated and due on a monthly basis.

9. PATENT INFRINGEMENT

9.1 Purchaser shall be indemnified and held harmless by Solarchem against any claim of infringement of any Canadian or United States Patent rights of any third party on account of any use of the Equipment and processes associated with the Rayox[®] water remediation system installed and started up by Solarchem in accordance with the terms of the Purchase Order and for any Purchaser activities conducted prior thereto in preparation for issuance of said Purchase Order.

10. DAMAGES AND LOSS CLAIMS

10.1 Seller shall carefully pack all Equipment sold hereunder and the Seller shall assume no responsibility for damage after having received "in good order" receipts from the carrier at Seller's works.

10.2 All claims for loss, damage and delay in transit are to be transacted by the consignee directly with the carrier. Claims for shortages or incorrect equipment must be made in writing to the Seller within fifteen (15) days after receipt of the shipment. Failure to give such notice shall constitute unqualified acceptance and a waiver by the Purchaser of all claims for shortages or incorrect equipment.

11. DESIGN CHANGES

11.1 Seller reserves the right to make changes in design or to add any improvement on Equipment or other goods at any time, without incurring any obligations to install same on equipment or goods previously purchased or leased.

12. TESTING AND ACCEPTANCE OF GOODS

12.1 Testing of the Equipment before shipment is carried out in accordance with Seller's test procedures and at its cost. Additional tests shall be agreed upon specifically between Seller and Purchaser and shall be charged to the Purchaser.

12.2 The Purchaser shall examine the Equipment upon taking possession of same and shall inform Seller immediately in writing of all defects and deficiencies for which Seller is responsible. If Purchaser omits to so notify Seller within thirty (30) days of Purchaser's possession of the Equipment, same shall be deemed to have been accepted.

12.3 Acceptance tests are carried out only if they have been agreed upon in writing by the Seller. As far as circumstances allow, such tests will be carried out in Seller's factory. If, for reasons beyond Seller's control, the acceptance tests cannot be carried out within the specified time, the qualities to be determined by these tests shall be deemed proved.

12.4 If it is found from one of the aforementioned tests that the Equipment does not fulfill the terms of the order, the Purchaser shall make available to Seller suitable opportunity to remedy any deficiency.

12.5 The Purchaser shall have no other rights than the rights outlined above in case of delivery of deficient equipment.

13. TECHNICAL DOCUMENTS

13.1 Technical documents, such as drawings, descriptions, illustrations and the like, and all weight data, shall serve as an approximate indication only, provided they have not been expressly specified as binding. Seller reserves the right to make any alterations considered necessary.

13.2 Purchaser shall ensure the confidentiality of all plans, drawings, technical specifications documents, software, microfilm, data or proprietary information relating to the Equipment sold, distributed, or manufactured hereunder. They shall remain Seller's exclusive property and may be neither copied nor reproduced nor communicated to a third party in any way whatever nor used for manufacture of the Equipment, or parts thereof. They may be used only for operation and maintenance of the Equipment, under terms and conditions specified by the Seller.

13.3 All documents submitted with tenders which do not result in an order shall be returned to Seller on request.

14. GENERAL

14.1 Purchaser shall not assign this contract, or any part thereof, without the written consent of the Seller.

14.2 Any order received by the Seller is subject to credit approval and may be cancelled if the Purchaser's credit standing is not satisfactory to Seller.

14.3 This Agreement and any order or contract placed hereunder shall be interpreted according to the laws of the State of Nevada.

14.4 Purchaser and Seller acknowledge having specifically requested that this Agreement and all related documents and correspondence be drafted in English.

14.5 Any addenda or appendices to this Agreement, to be applicable to any order hereunder, must be signed by both Purchaser's and Seller's respective representatives.

15. LAMP DISPOSAL

15.1 All spent lamps are to be returned to Solarchem Offices for disposal.

SECTION 6

STATEMENT OF QUALIFICATIONS

6.1 OVERVIEW

Solarchem Environmental Systems is the leading firm in Advanced Oxidation Processes (AOP) and has over eighty commercial installations throughout the world. Its sole business is the development, manufacture, and sale of equipment for the destruction of waterborne organic contaminants by photochemical processes. Solarchem's corporate goal is to maintain its position of leadership through extraordinary commitment to research and development, excellence in design, quality centered manufacturing, and customer oriented service.

Manufacturing

Solarchem occupies a new 19,000 square foot building located in the town of Markham just north of Toronto. Its workshop has a full complement of equipment and tradesmen to manufacture and assemble all systems in-house. In addition, Solarchem works with U.S. fabricators to provide additional fabrication capability to ensure that project schedules can be met during busy times.

Quality plays a major role at Solarchem in the manufacturing cycle with a well established Quality Assurance program. In addition, all systems undergo a detailed hydraulic and electrical function test prior to shipment.

As a vital part of Solarchem's manufacturing and assembly operation, high standards of quality are maintained by documented and thorough inspection procedures for critical purchased components such as power supplies and lamps, as well as for all machined parts. Systems are carefully assembled and thoroughly tested for up to 24 hours, using customer provided water if requested, before shipment. Overall quality control is the responsibility of the Manufacturing Manager. It should be noted that Solarchem's quality assurance procedures have met the exacting standards of the U.S. Navy and NASA as part of recently completed contracts highlighted in Section 6.3 below.

Solarchem is a CSA (Canadian Standards Association) certified manufacturer. CSA is recognized by the U.S. Occupational Safety and Health Administration (OSHA) as an accredited Nationally Recognized Testing Laboratory (NRTL). On August 18, 1993, the Department of Building and Safety of the City of Los Angeles approved CSA as an Electrical Testing Laboratory. Solarchem facilities are inspected regularly to ensure that the high standards of CSA are maintained.

Statement Of Qualifications

Customer Service

Solarchem maintains service personnel in Toronto ON, and Las Vegas NV to assist owners during system commissioning as well as to provide a full range of after-sales service to customers. Furthermore, Solarchem has contractual arrangements in place with qualified instrument sub-contractors to complement its own service personnel such as to assure rapid response to service requirements throughout North America.

Solarchem's service capability far exceeds the minimum requirement of servicing Rayox® systems through the twelve-month warranty period. Optional Periodic Maintenance agreements provide for regular visits by Solarchem Service Personnel to provide scheduled preventative maintenance. Full Service agreements provide all labor and materials for the complete operation of a system.

Engineering

Solarchem's process engineering group provides the practical expertise for designing and installing treatment systems. The process engineering group becomes involved at the design test stage and follows a given project through process specification, materials selection, process control, quality control testing and installation. Individual responsibility is the key to ensuring project congruence and high quality.

Solarchem's product engineering group includes electrical and mechanical engineering personnel as well as mechanical and electrical CAD designers. This group has many years of experience in designing and building UV/oxidation systems.

Project Management

Once a contract has been awarded to Solarchem, the point of contact is transferred from the responsibility of the sales representative to the Director, Installations. He works with the customer's representative to ensure that all of the contract requirements are satisfied in a timely and effective manner. This effort includes issue of drawings, coordinating drawings approval with the owner's representative, issuing Operating and Maintenance manuals, and coordinating Solarchem's training of the owner's operation and maintenance personnel as well as technical supervision during the commissioning of the Rayox® system.

Research and Development

Solarchem's most valuable asset is its intellectual property. Even more valuable than its numerous process and product design patents and its non-patentable know how are the expertise and experience of its staff. This staff includes no fewer than four Ph.D. photochemists, dedicated to photochemical contaminants destruction, a resource unmatched in the world.

Continuing projects for Solarchem's R&D staff include extending the application of AOP through the development of innovative processes, improving the commercial application and competitiveness of existing processes, improving organics analytical capabilities, and researching areas of new application.

6.2 KEY FEATURES OF RAYOX® TECHNOLOGY

- **Proprietary Low Wavelength UV Lamps**

Destruction of target compounds during UV oxidation treatment occurs both by hydroxyl radical attack and direct photolysis. Therefore, it is critical for the UV lamp to have maximum energy output in the UV wavelengths where hydrogen peroxide and the target compounds absorb energy the greatest.

H₂O₂ and the target compounds have maximum UV absorbance peaks below 220 nm. Solarchem UV lamps have far greater output in these wavelengths than any other commercially available UV lamp. Since the light emitted below 225 nm will actually break bonds and destroy the molecule, the Solarchem Lamps are also uniquely able to provide destruction by direct photolysis. The strong output of the Solarchem Lamp below 225 nm also enables more efficient production of hydroxyl radicals from the splitting of peroxide. This means that a Rayox® system can be smaller, reducing equipment purchase and operating costs.

- **Proven Programmable Logic Controller**

Solarchem has installed a PLC in every system already built. Approximately one half of Solarchem's installed PLC's interface directly with plant controllers. A state-of-the-art operator interface mounted on the control panel enables on-line optimization of the Rayox® system performance.

- **Proven Lamp Cleaning Mechanism**

Solarchem's patented lamp wiping mechanism has been included in all of its installations. The wiper mechanism is air-actuated and does not rely on reverse flow of water. It, therefore, requires fewer replacement parts and no by-pass piping, which reduces complexity. Furthermore, its operation is continuously monitored and verified by the PLC system to ensure its integrity.

- **Inherently Simple Design**

The Rayox® system is inherently simple by design. For example, a Rayox® system does not require a rupture disk to avoid an overpressure condition. Such a condition cannot occur through normal operation of the Rayox® system as it is designed to withstand a pressure of 50 psig. This avoids the need to register and maintain such a safety device.

- **Proprietary ENOX Photocatalysts**

Solarchem has developed four proprietary ENOX photocatalysts which can be used, individually or in combination, to optimize the treatment process selected for a given application. One of these ENOX photocatalysts is at the heart of a unique photoreduction process, Rayox®-R, which significantly improves the treatment of halogenated alkanes like TCA, DCA, CCl₄, and CHCl₃, all of which treat slowly by conventional photooxidation technologies. A second ENOX photocatalyst is highly active in the visible light range, and has potential solar applications through Solarchem's Solaqua® process.

Solarchem utilize a family of treatment processes which can treat a wide range of water-borne contaminants. Using its proprietary ENOX photocatalysts, Solarchem is able to customize the advanced oxidation and/or reduction process for each application, thereby minimizing the capital and operating costs for the client.

- **Other Rayox® Advantages**

Vertical reactors with internal baffles for superior turbulence to increase mass and energy transfer

> 90% power efficiency

0.92 power factor at full power

Stainless steel parts, nuts, bolts

100 message alarm annunciator

High pressure tolerances (50 psig)

Lamp power control keeps lamp UV output constant over time

6.3 CASE HISTORIES

Solarchem has designed and built over seventy commercial scale Rayox® advanced oxidation systems, approximately three-quarters of which are treating VOC's and semi-volatiles ranging from chlorinated solvents to aromatics in gasoline. As a result of this effort, and the high quality of its work, Solarchem is proud to include major corporations such as ICI, Exxon, Mobil, Hoechst Celanese, W.R. Grace, United Technologies, Uniroyal Chemical, Nestle, Martin Marietta, and agencies of the U.S. government including the U.S. Navy, the U.S. Air Force, and NASA in its current customer base.

This section outlines a brief selection of Solarchem's relevant design and commercial installation experience.

Systems in use:

- At Kelly AFB in San Antonio, Texas where Roy F. Weston, Inc. is the prime engineering contractor, there are two current applications treating groundwater. The first 3 x 30 kW Rayox® system will treat vinyl chloride, DCE, and other VOC's at

163 gpm. The second 9 x 30 kW Rayox® system will treat DCA, TCA, TCE, and other VOC's at 250 gpm. These systems started up in October 1993.

- At a former dry cleaning operation in Santa Barbara, CA, a 2 x 6 kW Rayox® system is treating PCE in groundwater. This system treats 25 gpm of groundwater from 20 ppm PCE down to < 1 ppm, with the remainder polished by GAC.
- At a service station in Carson City, Nevada, a 1 x 30 kW Rayox® system was installed in October 1991 to treat BTEX in groundwater. This system destroys BTEX from 1 ppm down to < 5 ppb at a flowrate of up to 10 gpm.
- At a terminal in Albany, NY, a 3 x 30 kW Rayox® - T system was installed in November 1991 to treat BTEX in tank bottom water. This system destroys BTEX from 20 ppm down to < 5 ppb at a flowrate of 100 gpm.
- At a location in Troy, Ontario, a 1 x 30 kW Rayox® system was installed in February 1992 to treat BTEX in groundwater. This system destroys BTEX from 9 ppm down to < 5 ppb at a flowrate of 26 gpm.
- At a decommissioned refinery in Mississauga, Ontario, a 1 x 10 kW Rayox® system was installed in December 1992 to treat BTEX and chlorinated organics in groundwater. This system destroys the target compounds from 3 ppm down to < 10 ppb at a flowrate of 3 gpm.
- At the Six Nations Reserve at Ohswekan, Ontario, a 1 x 30 kW Rayox® system was installed in September 1993 to treat NDMA in drinking water. This system destroys NDMA from up to 100 ppt NDMA down to < 5 ppt at flowrates up to 88 gpm.
- At a rubber manufacturing facility in South-Western Ontario, a 1 x 10 kW Rayox® system is treating NDMA in rinse water. This system destroys NDMA from 20 ppb NDMA down to < 0.5 ppb ppt at a flowrate of 10 gpm.
- At the Wells G&H Superfund site in Woburn, Mass. a 2 x 5 kW Rayox® system is treating up to 30 gpm of groundwater from 2 ppm total chlorinated VOC's to below detection on each of 1,2-DCE, TCE, PCE and vinyl chloride.
- A Rayox® system was installed in March 1991 at the Uniroyal Chemical plant in Elmira, Ontario. This nine (9) 30 kW reactor system treats dimethylnitrosamine (NDMA) from 600 ppb to less than 500 ppt at a flow rate of 80 gpm. A second system of 9 x 30 kW reactors treating groundwater containing Chlorobenzene, NDMA, etc. was installed and started up in January 1992.
- At Elmira, Ontario, an 8 x 30 kW Rayox® system is treating groundwater at 600 gpm, with NDMA destruction from 20 ppb to < 30 ppt.
- A UV/peroxide based groundwater system has been operating at Nestle plant in Freehold, N.J. since April 1991, treating trichloroethylene (TCE) and other VOCs from 33 ppm to less than 5 ppb at a flow rate of 8 gpm.
- A groundwater system has been operating at the T.R. Miller plant in Brewton, Alabama since July 1990, treating PCP and PAH's from 5 ppm to less than 1 ppb at a flow of 105 gpm. A second system of 2 x 30 kW reactors treating PCP from 8 ppm to less than 9 ppb at a flow of 14 gpm was installed and started up in October 1991.

- At the International Paper site in Joplin, Missouri, a 2 x 30 kW Rayox® system is treating up to 120 gpm of groundwater from 1 ppm PCP to < 10 ppb PCP. The system was installed in November 1991.
- A process water system using Solarchem's Rayox®-R process to treat rocket fuel (hydrazine, NDMA) for NASA at Kennedy Space Center, Florida was commissioned in June 1993.
- A significant customer is the US Navy for whom we have built a 4 x 30 kW Rayox® reactor system to treat the semi-volatile compound nitroglycerine in process wastewater at the Indian Head Naval Ordnance Station.
- A groundwater system treating vinyl chloride, DCE, and other VOC's at Kelly AFB in San Antonio Texas started up in July 1993. The system is a 1 x 30 kW Rayox® reactor unit treating the VOC's at 55 gpm.
- A 1 x 30 kW process water Rayox® system to treat rocket fuel, (hydrazines, NDMA) at the Martin Marietta plant in Denver, Colorado started up in July 1993.
- At an aerospace company in California, a 1 x 30 kW Rayox® system is treating MEK in steam condensate from a carbon regeneration system. This system treats in discrete batches from 35,000 ppm MEK down to < 1 ppm MEK.
- A process water system has been operating at a Domtar plant in Trenton, Ontario since 1988, treating phenols and PCP from 200 ppm to less than 10 ppb at a flow of 2,000 gpd.
- At a location in New Jersey, where ERM is the prime engineering contractor, there is an application under construction to treat groundwater containing PCE, TCE, VC at 200 gpm. This 6 x 30 kW system started up in February 1994.
- At a State Superfund site in California, there is an application under construction to treat groundwater containing PCE, TCE, DCE and TCA at 12 gpm. This 1 x 30 kW Rayox® system started up in February 1994.
- At a location in New Zealand, there is an application to treat groundwater containing PCP at 60 gpm. This 4 x 30 kW system was commissioned in July 1994.
- At a location in West Virginia, there is an application to treat process water containing NG at 2 gpm. This 2 x 30 kW system was started-up in December 1994.
- At a location in Maine, there is an application to treat groundwater containing VOC's at 30 gpm. This 30 kW system was started-up in November 1994.
- At a location in Kansas, there is an application to treat groundwater containing various VOC's at 5 gpm. This 1 x 30 kW system was started-up in November 1994.
- At a US Army base in Maryland, there is an application to treat groundwater containing TDG at 30 gpm. This 60 kW system was started-up in January 1995.
- At a location in Michigan, there is an application to treat groundwater containing high concentrations of DCP and TCE. This 60 kW system was started-up in February 1995.

Statement Of Qualifications

- At a location in North Carolina, there is an application to treat groundwater containing 1,4-Dioxane at 615 gpm. This 270 kW system was started-up in February 1995.
- At a nuclear power plant in Ontario, there is an application to treat process water containing various organic contaminants at 2 gpm. This 10 kW system was started-up in March 1995.
- At Kelly Air Force base in Texas, there is an application to treat groundwater containing VOC's at 200 gpm. This 180 kW system was started-up in March 1995.
- At a manufacturing plant in Massachusetts, there is an application to treat process water containing thiourea and formaldehyde in 2,000 gpd batches. This 60 kW system was started-up in March 1995.

Systems under construction:

- At an aircraft manufacturing plant in Colorado, there is an application to treat groundwater containing acetone at 8 gpm. This 120 kW system is scheduled for start-up in June 1995.
- At McClellan Air Force base in California, a system is being constructed to treat groundwater containing TCE at 380 gpm. This 180 kW system is scheduled for start-up in August 1995.
- At a synthetic resin manufacturing facility in Spain, there is an application to treat groundwater containing substituted dioxanes at 33 gpm. This 90 kW system is scheduled for start-up in August 1995.
- At Brooks Air Force base in San Antonio, Texas, a system is being constructed to treat groundwater containing TCE at flowrates up to 75 gpm. This 30 kW system is scheduled for start-up in September 1995.
- For Argonne National Laboratory, a system is being constructed to destroy mixed organic wastes in intermittent batches. This 30 kW system is scheduled for start-up in September 1995.
- For the Lockheed plant in Fort Worth, Texas, a system is being constructed to treat acetone and other contaminants at a flowrate of 30 gpm. This 180 kW system is scheduled for start-up in September 1995.

6.4 KEY PERSONNEL

This section outlines the caliber of technical support, engineering and research staff available to support any proposed system and its successful application once installed.

The qualifications of Solarchem's forty technical management and staff members stand second to none in the advanced oxidation/reduction field. With four Ph.D.'s in photochemistry, and a strong commitment to product and process enhancement, the company's depth of technical know-how and experience ensure that any Rayox® system

will operate as required. Additional services and support capabilities are available for a system supplied by Solarchem including the services of a full field service team..

Qualifications and Experience of Key Personnel

P. Daniel Nolan, B.A.Sc., M.A.Sc., P.Eng.
President and CEO, Solarchem Enterprises Inc.

Dan Nolan has overall responsibility for the operation of the Company. He is responsible for the financial performance of the Company. He has functional responsibility for research and development, process and product engineering, manufacturing, finance and administration, including human resources.

Mr. Nolan joined Solarchem in 1992. He has held general management, strategic planning, sales and marketing, manufacturing and process engineering positions in large chemical manufacturing firms. This experience has been applied across the industrial and specialty chemicals manufacturing and the process systems contracting industries. Areas of specific application knowledge include wastewater treatment, potable water treatment, sulfur dioxide abatement and acid recovery and reconcentration. His background includes negotiating commercial contracts with both private sector concerns and Municipal and Federal Government departments.

Dan Nolan graduated from the University of Windsor with a B.A.Sc. and an M.A.Sc. in Chemical Engineering. He is a Registered Professional Engineer in the Province of Ontario.

R.D. Samuel Stevens, B.Sc., Ph.D.
President, Solarchem Environmental Systems, Inc.

Dr. Stevens is responsible for the operation of Solarchem Environmental Systems Inc. and has overall responsibility for the Sales and Marketing activities, including sales management, negotiating commercial terms and conditions, and direction of the sales support functions, as well as marketing planning and promotion. Due to his strong technical background, he also contributes substantially to the technical direction of the Company. He is the inventor or co-inventor of several patents in the area of environmental technology and chemical manufacturing processes. He has written a large number of technical reports and presentations as well as several articles for scientific journals.

Dr. Stevens joined Solarchem in 1984. His background includes several years of experience as a research scientist and R&D Manager in Environment Canada and the Ontario Ministry of Environment. He was a founding partner and Senior Vice President of Concord Scientific Corporation before joining Solarchem.

Statement Of Qualifications

Dr. Stevens holds a B.Sc. in Chemistry from Mount Allison University and a Ph.D. in Chemistry from the University of New Brunswick. Dr. Stevens also completed Post Doctoral studies at the Departement de Chimie Physique de l'Université de Bordeaux. He is a past member of the Natural Sciences and Engineering Research Council of Canada (NSERC), the Canadian counterpart to National Science Foundation in the United States.

Keith G. Bircher, B.Sc., P.Eng.
Vice President, Engineering

Keith Bircher has overall responsibility for the Engineering and Research and Development activities at Solarchem. These include the engineering of Rayox® systems, design testing and treatability studies of customer waters, field pilot testing, site remediation, and research activities into new products and processes. Mr. Bircher is also responsible for engineering standards and controls as well as Solarchem's continuous improvement program. Mr. Bircher joined Solarchem in 1988.

Keith Bircher has wide ranging experience in chemical manufacturing as well as in business. His background includes engineering management, plant start-up, process design, control and optimization. He has extensive experience in gasifiers, energy from waste processes, and waste incineration as well as in water treatment.

Mr. Bircher holds a B.Sc. degree in Chemical Engineering. He is a Registered Professional Engineer in the Province of Ontario.

T. Peter O'Connor, P.Eng.
Vice President

Peter O'Connor has responsibility for promoting Solarchem's business interests in the United States, based in the Las Vegas office. Prior to joining Solarchem in 1987, he held engineering, design and construction positions with major international oil and chemical corporations. Mr. O'Connor has held several management positions with large international and smaller North American engineering construction groups in both the United States and Canada, associated with oil and gas treating, sulfur recovery, oil refining, copper and tungsten concentrators and a nuclear research reactor.

Peter O'Connor graduated from the University of Toronto with a B.A.Sc. degree in Civil Engineering and received a MIBA degree from United States International University in San Diego, California. He is a Registered Professional Engineer in the States of California and Minnesota.

Terry Spittles

Director, Installations

As Director of Installations, Terry Spittles is responsible for customer satisfaction from the point of sale through commissioning of the Rayox® system. He is responsible for coordinating all activities with the customer and for internal cost and scheduling control. Mr. Spittles joined Solarchem in 1990.

Prior to joining Solarchem, Terry Spittles worked with ABB Lummus Canada for many years. His responsibilities ranged from Senior Instrument Specialist up to Project Manager. His projects ranged territorially from Europe, North America and Asia. He has served the petrochemical, pulp and paper, metals refining, and chemical process industries.

Ronald C. Hallett, BA.Sc., P. Eng.

Manager, Product Engineering

Ron Hallett is responsible for all aspects of product design other than process engineering design. This includes mechanical, electrical and instrumentation design, including the computer-aided design function. Ron Hallett joined Solarchem in 1988.

Mr. Hallett has 15 years experience in the design of large material handling projects involving air-flow, hydraulics, plant layout and electronic control. He is the author of several patents. He has a wealth of practical mechanical knowledge as well as extensive experience in industrial engineering and quality control.

Ron Hallett holds a B.A. Sc. degree in Mechanical Engineering and he is a Registered Professional Engineer in the Province of Ontario.

Stephen Cater, B.Sc. (Hon. Chemistry), M.Sc., Ph.D

Manager Research and Process Engineering

Steve Cater is responsible for all aspects of process engineering, including the development of new photochemical processes. He directs design tests and treatability studies and is responsible for the operation of Solarchem's analytical laboratory. He is responsible for the process design of Rayox® systems. During his years at Solarchem he has been the chief researcher on a number of photochemical projects including the solar photochemical production of hydrogen peroxide, optimization of the Solair® air treatment process, and preliminary testing of the Solvolox® soil treatment process. Most of his current research is in the area of photochemical oxidation of water-borne and process optimization of the Rayox® process. Stephen Cater joined Solarchem in 1986.

Dr. Cater earned his M.Sc. degree in Chemistry from Brock University, and his Ph.D. in Chemistry from the University of Guelph. His Ph.D. was in the area of Organic Photochemistry.

Statement Of Qualifications

Robert Rayner, B. Comm., CPIM
Manager, Manufacturing

Robert Rayner has overall responsibility for the manufacture of Rayox® systems. His responsibility includes procurement of materials and components, production planning, supervision of manufacturing and assembly and shipping. Mr. Rayner is responsible for Solarchem's manufacturing quality program. He joined Solarchem early in 1993.

Bob Rayner has in excess of 12 years experience in all facets of management, primarily in manufacturing companies. His experience has encompassed all areas of logistics including purchasing, warehousing, planning, traffic, customs, master scheduling, forecasting and distribution management. In addition he has successfully managed the implementation of fully integrated manufacturing, planning and control systems.

Bob Rayner has a B.Comm. degree from the University of Toronto, and a certification in Inventory and Production Management.

Michael N. LeBer, CD, BA.Sc. P.Eng.
Manager, Customer Support

Mike LeBer is primarily responsible for providing the technical support to ensure a trouble-free startup and to train customers' personnel. Mr. LeBer is also responsible for providing periodic maintenance and full service maintenance and operation services to customers on a contract basis. As well as maintaining an inventory of spare parts at Solarchem and supplying spare parts to customers, Mr. LeBer maintains a 24 hour emergency technical service capability for customer support. Mike LeBer joined Solarchem in 1991.

Mr. LeBer has an extensive background in maintenance management, product engineering and project management. He has specific experience in equipment automation, troubleshooting training and project startups.

Mike LeBer graduated with a degree in Mechanical Engineering from the University of Toronto. He is a Registered Professional Engineer in the Province of Ontario.

Professor James R. Bolton, B.A., M.A., Ph.D.
Senior Research Fellow

Jim Bolton fills a critical role at Solarchem in performing basic research and development in the photochemical destruction of organic contaminants. His efforts are applied both in the extension of Rayox® technology and in the development of new processes. He has been very active in the Solair® and Solaqua® development projects. In addition to his work at Solarchem, Jim spends over half his time at the University of Western Ontario, where he actively directs a research program in addition to his teaching duties. Jim

Bolton has also held the position of Professor of Chemistry at the University of Minnesota and was a Boese Post-doctoral Fellow at Columbia University. Jim has held consulting positions with the Solar Energy Research Institute in Golden, Colorado and the Renewal Energy Branch, Energy Mines and Resources Canada. He has been the recipient of many distinguished awards in Canada, United States, Japan and China.

Ali Safarzadeh-Amiri, Ph.D
Research Scientist

Ali Safarzadeh-Amiri joined Solarchem as a Research Scientist in 1990 and his research involves the photochemical treatment of air-borne and water-borne pollutants. He has been very active in the development of the sunlight activated Solaqua® process for the treatment of water-borne organic pollutants. He holds a process patent.

Ali Safarzadeh-Amiri has spent five years doing Post-Doctoral Research at the University of Toronto, University of Waterloo and the University of Western Ontario. He worked for two years at a private firm, researching photocatalytic oxidation of pollutants. Dr. Safarzadeh-Amiri has authored or co-authored 23 journal articles in various fields of photochemistry and photophysics.

Dr. Safarzadeh-Amiri obtained his Ph.D. degree in Photophysics and Photochemistry from the University of Saskatchewan.

Robert Abernethy, P.Eng., M.B.A.
Sales Engineer

As a Sales Engineer for Solarchem, it is Rob Abernethy's responsibility to develop a thorough understanding of the customer needs to propose the Rayox® system which best satisfies these needs.

Since leaving University, Mr. Abernethy has acquired an extensive background as a project engineer for various mining and environmental projects throughout North America. His experience also includes working as a sales and product manager for an Earth Science Company specializing in highly technical instrumentation. Rob Abernethy joined Solarchem in the summer of 1992.

Rob Abernethy graduated from the University of Toronto with a Bachelor of Applied Science degree and went on to complete an MBA program as a Marketing Specialist at York University. He is a Registered Professional Engineer in the Province of Ontario.

Statement Of Qualifications

Martin Crawford, B.S., M.B.A

Sales Engineer

As a Sales Engineer for Solarchem, it is Martin Crawford's responsibility to develop a thorough understanding of customer needs and to propose the Rayox® system which best satisfies these needs.

Mr. Crawford has an extensive background working with commodity and specialty chemical companies in the area of sales, product management and marketing management. In his earlier years he spent several years working as a chemist performing research for the D.O.E. and chemical manufacturing processes. Martin Crawford joined Solarchem in 1994.

He graduated from Central State University in Edmund, Oklahoma with a Bachelor of Science in Chemistry, then completed a Masters of Business Administration at Golden Gate University in San Francisco, California.

Michael Jaubert, Jr., B.S.

Sales Engineer

As a Sales Engineer for Solarchem, it is Michael Jaubert's responsibility to develop a thorough understanding of customer needs and to propose the Rayox® system which best satisfies these needs.

Mr. Jaubert has over six years of sales and marketing experience in the hazardous waste treatment industry, specializing in incineration and wastewater treatment. He has an extensive background dealing with the aerospace, chemical, petroleum and other high tech industries. His experience also includes marketing environmental services to government agencies. Michael Jaubert joined Solarchem in 1994.

He graduated from the University of Southwestern Louisiana with a Bachelor of Science degree in Biochemistry and Microbiology.

Douglas Reed, B.Sc.(Hons)

Sales Engineer

As a Sales Engineer for Solarchem, it is Doug Reed's responsibility to develop a thorough understanding of customer needs and to propose the Rayox® system which best satisfies these needs.

Previously at Solarchem, Mr. Reed worked on a number of original research projects and has had major responsibility in building and operating a Vitamin D₃ pilot plant. He has also worked as a Project Scientist on over 40 Rayox® design tests and on site

Statement Of Qualifications

demonstration programs. Doug Reed joined Solarchem in 1985 and has acted as a Sales Engineer since 1991.

Doug Reed graduated from the University of Toronto with a B.Sc.(Hons.) specializing in Analytical and Organic Chemistry. While a student, he was the recipient of a NSERC Research Award.

Bachar Mourad, M.Sc. Mech.Eng, P.Eng.
Sales Support Engineer

Bachar Mourad currently provides custom engineering support for sales and marketing personnel. His principal responsibility is the preparation of technical and commercial proposals. He has accumulated a broad experience in project engineering and management from working with Stone & Webster on a variety of petroleum and water treatment related projects.

Bachar Mourad completed his undergraduate and graduate studies in Mechanical Engineering in Boston. He holds a B.Sc. degree from Northeastern University and an M.Sc. from Tufts University. He is a Registered Professional Engineer in the Province of Ontario.

Robert F. Notarfonzo, B.A.Sc., M.B.A.
Market Analyst/Sales Engineer

Rob Notarfonzo's primary responsibility is in the area of market assessment and development. He also matches customer needs to Rayox® systems. He joined Solarchem in early 1993.

Before joining Solarchem, Mr. Notarfonzo was in charge of market research, market assessment, and financial analysis for the Ontario Waste Management Corporation.

Rob Notarfonzo obtained his Masters in Business Administration from Wilfrid Laurier University after graduating from the University of Waterloo's Chemical Engineering program.

Michael Madigan, Dipl. Elect. Eng., M.I.E.I.
Electrical Engineer

Mike Madigan's principal responsibilities are electrical design, PLC programming, and system automation. He also is responsible for continued product development and automation. He joined Solarchem in 1990.

Statement Of Qualifications

Mr. Madigan received his Diploma in Electrical Engineering. Previous to joining Solarchem his experience includes material handling, packaging and process control both in Canada and Ireland.

Sandro Pecile, B.A. Sc., P.Eng

Project Engineer

Sandro Pecile is responsible for the mechanical design of all manufactured systems and also supplies support for all field service technicians. He joined Solarchem in 1989.

Mr. Pecile received his Mechanical Engineering degree from the University of Toronto.

Timothy D. Riddle, B.A.Sc.

Project Engineer

Tim Riddle is responsible for all electrical and Autocad three dimensional drawings at Solarchem. He was involved with the final stages of development of the Rayox® reactor.

Mr. Riddle joined Solarchem in 1991 after completing his Mechanical Engineering degree from the University of Toronto.

Karen Simms, B.Sc. Chem. Eng., P. Eng.

Process Engineer

Karen Simms is responsible for providing process engineering input during specification, design, construction and commissioning of all manufactured systems. She is also involved in continuing research and process development. She joined Solarchem in 1994.

Ms. Simms received her Chemical Engineering degree from the University of Alberta and worked as a process engineer in the wastewater treatment field prior to joining Solarchem.

Wayne Lem, B.A.Sc., P. Eng.

Process Engineer

Wayne Lem is responsible for all process engineering for systems. His primary responsibility is to determine the optimal and most cost-effective system configuration. Wayne is responsible for sizing equipment and providing input on process control for systems. He is also continually involved in research and process development. He joined Solarchem in 1994.

Mr. Lem received his Chemical Engineering degree from the University of Toronto and worked as a process engineer in the field of water treatment prior to joining Solarchem.

Statement Of Qualifications

Ernest Selvadurai
Service Technologist

Ernie Selvadurai's primary responsibilities are commissioning systems after delivery, customer training, system test before shipment, maintenance, warranty, contract services and individual customer contact. He joined Solarchem in August, 1990.

Mr. Selvadurai is a graduate of Seneca College's Electronic Engineering Technology program. He subsequently completed several courses in electronics at the University of Toronto. This was followed by five years experience as a service engineer in the sensor design industry.

David L. Mulholland
Service Technician

David Mulholland is responsible for the installation, repair and maintenance of Rayox® systems. His primary responsibility is providing on-site service and technical support to customers requiring advice and/or maintenance to systems in service.

David Mulholland has worked in the electrical field for more than twenty years in the capacity of Electrical Systems Test Specialist and Electrical Engineering Technician. Accordingly, during this time he has earned extensive experience with electrical/electronic PLC control systems.

Vera Reichman
Chemical Technician

Vera Reichman is responsible for the analysis of design test samples and carries out a portion of the pilot scale studies on water treatment. She joined Solarchem in 1987.

Ms. Reichman completed a course of study in Chemical Engineering Technology at the Institute of Technology in Haifa, Israel. Since graduating, she has worked as a junior Chemical Engineer at two research laboratories in Israel.

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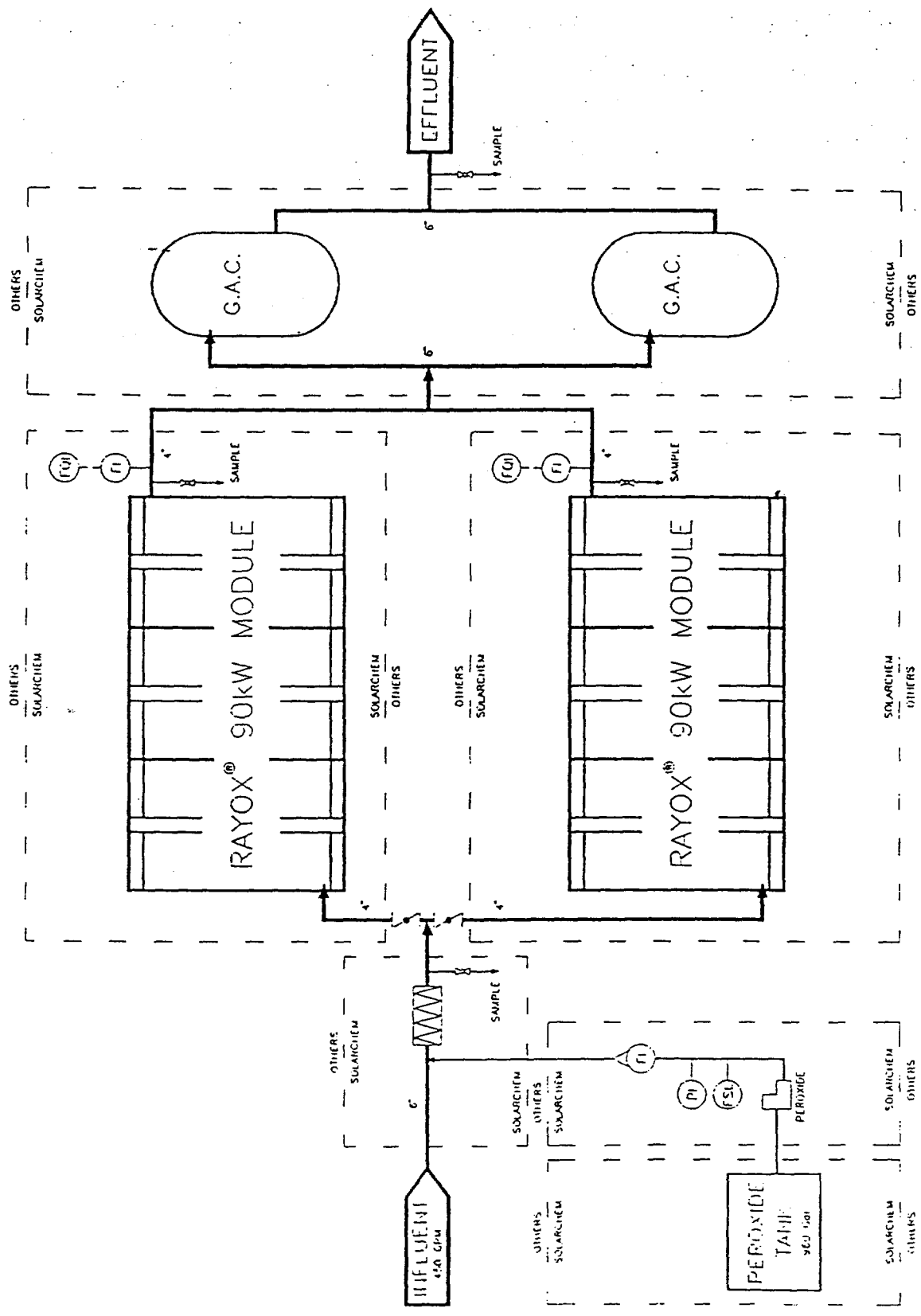
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540-D-500641

Design of a UV Oxidation System for Treatment of TCE-Contaminated Groundwater

Barbara A. Weir, Cinthia Rudasill McLane

Metcalf & Eddy, Inc., 30 Harvard Mill Square, Wakefield, MA 01880

and

Robert J. Leger

Environmental Protection Agency, Region 1, JFK Federal Building (HBO), Boston, MA 02203

Several design issues were encountered by EPA and Metcalf & Eddy during the design of a UV oxidation system for treatment of TCE-contaminated groundwater at the Groveland Wells Superfund Site. The issues included: 1) the need to execute treatability studies of the UV oxidation technology, as required by the Record of Decision, to provide data needed to develop a more accurate design and cost estimate; 2) the need to evaluate pretreatment options for removal of inorganics prior to UV oxidation, both to minimize maintenance problems and to ensure that applicable discharge limits for metals would be met; 3) the need to evaluate measures for ensuring that residual oxidant(s) in the effluent from the UV oxidation system would not cause the effluent to exceed toxicity limits for discharge to surface water, and 4) the need to develop a performance specification for the UV oxidation system which would ensure fair competition among vendors of UV oxidation systems, while also ensuring that EPA would receive a system which is cost-efficient and able to meet discharge limits.

Metcalf & Eddy competitively procured a UV oxidation vendor to perform bench-scale treatability studies on site groundwater and designed a pretreatment system consisting of an equalization tank, inclined plate clarifier, and dual media filters. The specification for the UV oxidation system was written to allow the UV oxidation vendor maximum flexibility while still ensuring that discharge limits for VOCs of concern and toxicity are met. The specification allows for the use of hydrogen peroxide, ozone, or a combination of the two as the oxidant and requires that the effluent not exceed toxicity limits. The vendor is allowed to meet toxicity limits either by using oxidant concentrations that result in a non-toxic residual, or by installing a module to reduce residual oxidant concentration(s) to non-toxic levels before discharge. This approach allows the vendor to use process alternatives that result in an overall system which minimizes costs.

INTRODUCTION

Metcalf & Eddy (M&E), under the EPA Alternative Remedial Contracting Strategy (ARCS) contract number 68-W9-

0036, has completed the remedial design of a groundwater extraction and treatment system for remediation of contaminated groundwater at the Groveland Wells Superfund Site in Groveland, Massachusetts. In accordance with the Record of Decision (ROD) for the Management of Migration Operable Unit [1], the groundwater treatment system consists of an ultraviolet (UV) light-catalyzed oxidation system for the destruction of volatile organic compounds in the groundwater with discharge of treated groundwater to an on-site surface water body, Johnson Creek. The ROD specified that treatability studies of the UV oxidation technology be performed on site groundwater to evaluate the effectiveness of the technology prior to completion of the remedial design. A pretreatment system to remove inorganic material (in particular, suspended solids, iron, and manganese) from the groundwater prior to UV oxidation treatment was also described in the ROD. However, at the time the ROD was written there was insufficient data on the concentrations of inorganic constituents in the groundwater to determine whether removal of inorganics would be needed either to allow efficient operation of the UV oxidation system, or to comply with surface water discharge limits to Johnson Creek. EPA Region I issued a work assignment to M&E which included the following pre-design and remedial design activities:

- Performing bench-scale treatability studies of the UV oxidation technology to establish its effectiveness and obtain data needed for remedial design
- Performing additional groundwater sampling to better characterize the concentrations of inorganic constituents in site groundwater and establish design basis concentrations for the inorganics removal portion of the groundwater treatment system
- Groundwater modeling and design of the groundwater extraction system
- Design of the groundwater treatment system according to a performance-based approach, in which treatment equipment is specified in terms of meeting discharge criteria and other performance-related goals
- Detailed design of the underground pipeline, the treatment plant site itself, and the discharge structure to Johnson Creek

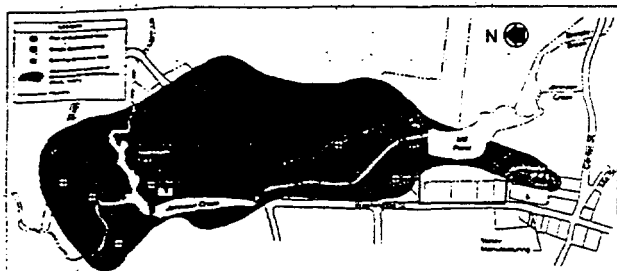


FIGURE 1 Proposed locations of treatment plant, pipeline, & extraction wells.

- Preparation of bid documents for construction and one year of operation of the groundwater extraction and treatment system

SITE DESCRIPTION

The 850-acre (340-hectare) site is the location of a plume of halogenated volatile organic compounds (VOCs) in groundwater (Figure 1). The primary VOC of concern at the site is trichloroethylene (TCE). The site encompasses the approximate limits of the stratified drift aquifer that serves as the source of water for the current and former municipal supply wells. A large, active sand and gravel operation is located in the central area of the site.

Groveland municipal well stations No. 1 and No. 2 are both located in the northern portion of the site. In 1979, sampling and analysis of water from Station No. 1 and Station No. 2 revealed the presence of TCE in concentrations as high as 118.8 µg/l at Station No. 1 and 108.7 µg/l at Station No. 2. The Groveland Wells Site was placed on the National Priorities List (NPL) in 1982.

The selected remedy for site groundwater consists of extraction and treatment for an estimated period of 30 years. The design extraction rate is approximately 400 gallons per minute (91 m³/h). The extracted groundwater is to be treated by UV oxidation for the destruction of VOCs and then discharged to Johnson Creek. The site extraction wells, pipeline location, treatment plant location, and TCE plume location are shown in Figure 1. A schematic diagram of the treatment system is shown in Figure 2.

TREATABILITY STUDIES

Treatability studies of the UV oxidation technology were performed on site groundwater in the spring of 1994. Jar tests were also planned to evaluate options for removal of metals (iron in particular) before UV oxidation treatment. The jar tests were not carried out due to low concentrations of metals in the treatability study sample, however. The overall objectives of the treatability studies as planned were to: 1) collect information needed to design a pretreatment system to remove suspended solids and dissolved metals prior to the UV oxidation portion of the groundwater treatment plant, such that both the operational requirements of the UV oxidation system and the surface water discharge limits for metals would be met; and 2) collect information needed to design the UV oxidation system for the destruction of VOCs, such that surface water discharge limits for the VOCs of concern would be met in a reliable and cost efficient manner.

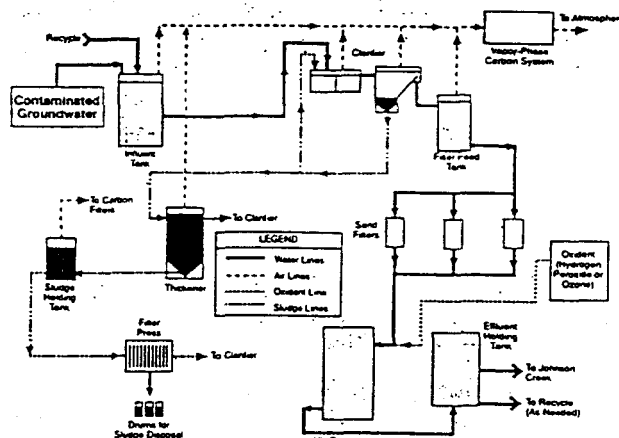


FIGURE 2 Treatment system schematic.

Approach

A subcontractor was competitively procured by M&E to perform bench-scale treatability testing of metals pretreatment and UV oxidation technologies for treating site groundwater. The subcontractor was selected after evaluation of several responses to a Request for Proposals (RFP) developed by M&E. The RFP was sent to six vendors of UV oxidation technologies. The vendor who submitted the lowest-price technically qualified proposal was selected to carry out the studies, with the understanding that award of the treatability study contract was not to be construed as an agreement to purchase the full-scale system from the selected vendor. The selected vendor was Solarchem Environmental Systems of Markham, Ontario, Canada. M&E staff collected a composite groundwater sample from selected on-site monitoring wells and sent it to Solarchem for use in their bench-scale testing. Under the direction of M&E, confirmatory treatability study samples were collected and submitted for analysis of VOCs and total metals by EPA Contract Laboratory Program (CLP) laboratories. The purpose of these samples was to provide an independent check on the subcontractor's results.

Sample Collection and Shipment

M&E collected approximately 120 gallons (450 liters) of water from wells at the site for use in treatability testing. Water was collected from each well by a submersible pump and discharged into five-gallon polyethylene carboys with a minimum of agitation. Water from each of the wells was composited into four polyethylene drums for shipment by truck.

Compositing was conducted with care to minimize volatilization losses during pouring, and the drums were filled as much as possible to minimize headspace losses. However, due to the geometry of the drums, it was not possible to completely eliminate headspace. Samples of water were collected from each drum after compositing was completed and submitted to a CLP laboratory for VOC analysis. The purpose of these samples was to quantify volatilization losses during compositing, as well as to quantify the VOCs in the drums prior to shipment so that VOC losses during shipment could be quantified.

Upon arrival, the contents of the drums were composited to create a single sample, from which a subsample was

withdrawn and analyzed for VOCs and unfiltered metals by Solarchem's laboratory, Environment Protection Laboratories (EPL). Forty-eight hour turnaround was specified for these samples because the treatability studies could not begin until the results were available and used to determine appropriate starting conditions for the studies. Split samples were submitted to CLP laboratories, under the direction of M&E, for analysis of VOCs, total metals, and filtered metals.

The analytical results from the CLP laboratories for selected VOCs in the individual wells, in the drums, and in the water after compositing indicated that during shipment and compositing there was a reduction in TCE concentration of approximately 36 percent and a reduction in the total 1,2-dichloroethene concentration of 8 percent. However, even with these losses, it was decided that the concentrations of these VOCs were high enough to proceed with the treatability studies without having to spike the sample.

The original treatability study scope of work called for the treatability study vendor to perform bench-scale treatability studies of both metals pretreatment technologies and the UV oxidation technology. To determine appropriate metals pretreatment schemes for testing, Solarchem was required to have samples of the untreated groundwater composite analyzed for unfiltered and filtered metals with 48-hour turnaround time. When the results for these samples were received, it was observed that the concentrations of metals were low enough that no pretreatment would be necessary. Solarchem notified M&E of these results and it was agreed that pretreatment tests should not be performed due to the low concentrations of metals in the sample. Solarchem was directed to forgo the metals pretreatment studies and proceed directly to the UV oxidation studies. The results indicating low metals concentrations were confirmed by additional groundwater monitoring conducted by M&E.

Procedures and Apparatus

The UV oxidation studies were performed using a 1-kilowatt bench-scale unit. Sample water was added to the unit, an initial sample was taken, the appropriate quantity of hydrogen peroxide was added, and the UV lamp was ignited. The time of lamp ignition is considered to be time zero. Samples were collected at periodic intervals and immediately analyzed for TCE to follow the progress of the test.

TCE was analyzed by direct injection into a gas chromatograph.

TCE concentrations were plotted as a function of UV dose. UV dose (in kWh/1000 gallons) was calculated as follows:

UV Dose (kWh/1000 gal)

$$= \frac{\text{Lamp size (1 kW)} \times \text{Time (min)} \times 3785 \text{ L/1000 gal}}{\text{Volume (L)} \times 60 \text{ (min/hour)}}$$

The plot was used to calculate the electrical energy per order (EE/O) for TCE. The EE/O is the electrical energy needed to reduce the TCE concentration by a factor of ten. The units typically used for EE/O are kWh/1000 gallons/order. It is calculated by the following equation:

$$\text{EE/O} = \text{UV Dose} / \{\log(C_i/C_f)\}$$

where C_i = TCE concentration at start of test
 C_f = TCE concentration at end of test

A semi-logarithmic plot of concentration vs. UV dose is generally linear and can be used to calculate EE/O; the reciprocal of the slope of such a plot is the EE/O.

Four different initial hydrogen peroxide concentrations were tested: 100, 50, 25, and 10 mg/l. Estimates of operating cost were made for each test run based on the EE/O and initial hydrogen peroxide concentration, the initial TCE concentration, and the final TCE concentration which must be attained (assumed to be the discharge limit of 212 µg/l). The test run which yielded the lowest operating cost was judged to be the optimal run. During testing, TCE analyses were conducted via direct aqueous injection into a gas chromatograph, in order to determine which test run produced optimum results.

The optimal test run was repeated to generate samples for analysis by Environment Protection Laboratories for VOC analysis. Samples of the untreated water and samples collected at three different time intervals were sent to EPL for analysis. Split samples of the water from the end of the test were sent to CLP laboratories for confirmatory analysis of VOCs, unfiltered metals, and filtered metals.

Solarchem calculated EE/O values and estimated operating costs for each initial hydrogen peroxide concentration. The EE/O values and operating costs are presented in Table 1. The operating cost is a function of the cost of hydrogen peroxide and the power cost for operating the UV lamps.

TABLE 1. Estimated Operating Costs and EE/O Values for Bench-Scale UV Oxidation Tests Performed by Solarchem

Test Number	Initial H ₂ O ₂ Concentration (mg/l)	EE/O Value (kWh/order/1000 gal)	H ₂ O ₂ Cost (\$/1000 gal)	UV Lamp Replacement Cost (\$/1000 gal)	Power Cost (\$/1000 gal)	Total Operating Cost (\$/1000 gal)
1	10	3.0	0.04	0.10	0.17	0.31
2	25	1.5	0.10	0.07	0.08	0.25
3	50	1.3	0.20	0.03	0.07	0.30
4	100	0.5	0.40	0.03	0.04	0.47

Source: Solarchem Environmental Systems, 1994. *Final Report on the Rayox® Design Test to Treat Groundwater at the Groveland Wells Superfund Site, Groveland, MA*. Table 4: Operating Costs as a Function of Peroxide Concentration.

Unit Conversions: EE/O Value (kWh/order/1000 gal) × 0.26417 = EE/O Value (kWh/order/m³)
 Unit Cost (\$/1000 gal) × 0.26417 = Unit Cost (\$/m³)

Results of Optimal Test Run

Table 1 shows that operation at an initial hydrogen peroxide concentration of 25 mg/l would be expected to provide the lowest operating cost. This run was repeated to generate samples for analysis by EPL and by CLP laboratories. Samples were collected at several time intervals, immediately analyzed for TCE, and also submitted to EPL for analysis of VOCs. Samples from the end of the test were submitted to CLP laboratories for analysis of VOCs, unfiltered metals, and filtered metals.

Solarchem calculated EE/O values for TCE from their own data and from the EPL data and found that the EE/O value determined from the EPL data was approximately double that determined from their own data. Solarchem concluded that the reason for the difference was that the TCE destruction rate was so fast during this test that the TCE concentration was below the detection limit of their method (30 µg/l) after only one time interval. Hence, the EE/O was calculated based on only one data point. The method used by EPL for TCE analysis is more sensitive than the quick screening method, attaining a detection limit of 1 µg/l. The TCE concentration could therefore be followed throughout the run and three data points were available for estimation of the EE/O. Solarchem performed all subsequent cost estimates in their report based on the more conservative EE/O value determined from the EPL data. In addition, they applied a correction factor of two to those EE/O values determined solely by their own laboratory's data to account for the discrepancy between their results and EPL's results.

The CLP laboratory detected two VOCs in the sample collected at the end of the optimum test: TCE at a concentration of 16 µg/l, and 1,1,1-trichloroethane at a concentration of 2 µg/l. This latter value is of limited accuracy because it is five times lower than the CLP Contract Required Detection Limit of 10 µg/l. Environment Protection Laboratories reported a TCE concentration of 9.9 µg/l for the optimum test run sample, and did not detect 1,1,1-trichloroethane. Given the level of accuracy attainable at concentrations as low as these, the agreement between the EPL results and the CLP results was judged to be satisfactory.

Cost Estimates

Table 2 summarizes the test runs and presents the residual hydrogen peroxide concentrations, EE/O values, UV doses, recommended system sizes, and respective estimated capital and operating costs. Note that system sizes, capital costs, and operating costs were based on attaining a discharge limit for TCE of 212 µg/l and were estimated using the most conservative EE/O values generated (i.e., those based on EPL's TCE data).

TREATMENT SYSTEM DESIGN

The groundwater treatment system is sized and configured to treat groundwater at an average influent flow rate of 400 gallons per minute (91 m³/h). Groundwater is pumped from six overburden/bedrock extraction well pairs to be installed downgradient of the source area, three extraction wells located in the source area, and two existing extraction wells that service an air stripper which is currently treating a small portion of the site VOC plume. This water is pumped via underground, double-walled high density polyethylene (HDPE) pipelines to an equalization tank located within the groundwater treatment plant building. All process piping is HDPE and all process tanks are epoxy-lined carbon steel.

The groundwater treatment train (Figure 3) consists of the following unit operations:

- Equalization
- Pretreatment to Remove Suspended Solids
 - Polymer Addition
 - Flocculation and Sedimentation
 - Filtration
- Ultraviolet (UV) Oxidation
- Sludge Thickening and Dewatering
- Vapor-Phase Carbon Adsorption Treatment of Tank Headspace Air
- Storage of Treated Effluent followed by Discharge to Johnson Creek

TABLE 2. Bench-Scale Test Conditions, EE/O Values, and Estimated Costs

Test Number	Process	Initial H ₂ O ₂ Concentration (mg/l)	Estimated	UV Dose (kWh/1000 gal)	System Size (kW)	Capital Cost (\$)	Operating Cost (\$/1000 gal)
			EE/O Value ^(a) (kWh/order/1000 gal)				
1	Rayox®	50	2.5	2.1	60	109,000	0.41
2	Rayox®	25	3.0	2.6	60	109,000	0.33
3	Rayox®	100	1.0	0.85	30	73,000	0.49
4	Rayox®	10	6.0	5.1	120	170,000	0.51
5	Rayox®	25	2.5	2.1	60	109,000	0.32

Source: Solarchem Environmental Systems, 1994. *Final Report on the Rayox® Design Test to Treat Groundwater at the Groveland Wells Superfund Site, Groveland, MA*. Table 5: Calculated EE/O Values for Rayox® Treatment, and Table 6: Cost Summary for Various Rayox® Treatments for TCE Treatment to 212 ppb.

Notes: (a) Estimated EE/O values are those calculated by Solarchem using the TCE data from Environment Protection Laboratories.

Unit Conversions: EE/O Value (kWh/order/1000 gal) × 0.26417 = EE/O Value (kWh/order/m³)

UV Dose (kWh/1000 gal) × 0.26417 = UV Dose (kWh/m³)

Operating Cost (\$/1000 gal) × 0.26417 = Operating Cost (\$/m³)

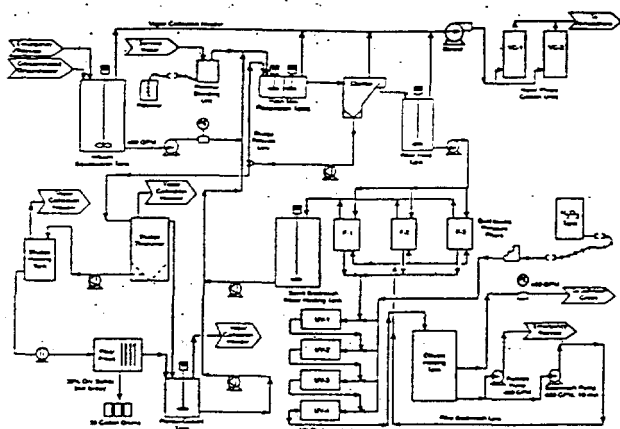


FIGURE 3 Process flow diagram.

Design Basis

The groundwater treatment facility is designed to operate at an average influent flow rate of 400 gpm (91 m³/h) during normal system operation. Process equipment was sized to accommodate a nominal 400 gpm influent flow rate plus backwash flows, where applicable. Small increases or moderate decreases in the influent flow rate can be accommodated by the treatment system without significant loss of efficiency.

Design influent groundwater concentrations for four VOCs of concern at the site (trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, and total 1,2-dichloroethylene); total suspended solids (TSS); and total metals were determined using the data collected by M&E during pre-design activities [2], in addition to data from previous investigations conducted at the site [3, 4]. The design basis concentrations, the interim cleanup levels specified in the ROD, and the discharge limits to Johnson Creek are compared in Table 3. The cleanup levels presented in the ROD were identified as "interim" because at the time the ROD was written, there were insufficient data regarding metals concentrations to determine whether groundwater remediation for metals would be necessary. The additional groundwater data collected by M&E in 1994 has demonstrated that groundwater metals concentrations are not in excess of the interim cleanup levels specified in the ROD, and hence EPA has judged those values to be no longer applicable to the Groveland site.

Pretreatment System

The pretreatment system was developed based on M&E's evaluation of the data obtained during the treatability study. The data showed that the concentrations of suspended solids and total metals in site groundwater were likely to be substantially lower than previous data collected during the Supplemental Remedial Investigation [3] had indicated.

The results of the groundwater monitoring effort performed by M&E concurrently with the treatability study also showed much lower total metals concentrations than were observed previously. It should be noted, however, that the samples collected by M&E during this effort were collected using the low-flow purge and sampling method re-

cently developed by EPA. This method eliminates the standard practice of purging three well volumes before sampling and attempts to minimize turbidity in the samples by withdrawing water from a well at the same rate at which it is recharging, such that the static water level does not change. Although the water collected for the treatability study composite sample was not collected by the low-flow method, all the individual well sample data collected by M&E were collected by this method. There is some question as to whether data collected by the low-flow method would be representative of what might be expected in an operating extraction well system, where higher flow rates will be maintained. The treatability study composite sample was collected by increasing the flow rate of the sampling pump to the maximum sustainable rate to more closely simulate the flow conditions which will occur during actual extraction well operation. It is considered likely that during start-up and initial operation of the extraction system, the suspended solids and total metals concentrations will be elevated and will decrease over time. Hence, pretreatment may be needed at least initially to prevent operating problems in the UV oxidation system.

A final concern with regard to pretreatment is the operating history of the on-site air stripper which is currently treating a small portion of the VOC plume. The air stripper reportedly required frequent maintenance due to elevated iron concentrations in the groundwater being treated in the air stripper. The two extraction wells that feed the air stripper will feed the UV oxidation system once it is constructed and the air stripper will be taken out of service. These two wells will represent approximately 10 percent of the total flow to the UV oxidation system.

A pretreatment scheme was developed to accommodate the above concerns and also eliminate process vessels (such as individual pH adjustment and oxidation tanks) which are unlikely to be needed for the full 30 years of plant operation. Suspended solids removal is achieved using a combination of coagulation/flocculation, clarification and filtration; separate steps for pH adjustment and oxidation are not included. The influent equalization tank has a detention time of 40 minutes at the design basis flow rate. This size will allow for later addition of a pH adjustment and iron oxidation step, should it be deemed necessary, by adding caustic and a chemical oxidant directly to this tank. A 40 minute detention time would allow sufficient time for oxidation to take place.

An inclined plate clarifier with attached rapid-mix and flocculation tanks is included to remove suspended solids. The clarifier can also remove precipitated metals should that become necessary. Dual media pressure filters are included to remove residual suspended solids which overflow the clarifier.

Sludge collected at the bottom of the clarifier which is not recycled is pumped to the 12,000 gallon (45,000-liter) sludge thickener. The thickener is sized to accommodate 24-hours' accumulation of clarifier underflow so that the filter press need be operated no more than once a day. Supernatant from the thickener overflows or is decanted into a 1300-gallon (4900-liter) filtrate/decant tank and is then pumped back to the clarifier. Gravity thickened sludge is pumped to the 1300-gallon (4900-liter) sludge holding tank. If it is determined during operation that there are problems with sludge consolidation and filtration, this tank could be retrofitted to allow addition of a conditioning agent.

TABLE 3. Design Basis Influent Concentrations, Interim Cleanup Levels, and Discharge Limits

Parameter	Design Basis Influent Concentration (µg/L)	Interim Groundwater Cleanup Level (µg/L)	Basis	Surface Water/Johnson Creek Discharge Limits	
				Average Monthly (µg/L)	Maximum Daily (µg/L)
Volatile Organics:					
Trichloroethylene	4,700	5	MCL	212	None
1,2-Dichloroethene (total)	810	70	MCL	108	None
Tetrachloroethene	190	5	MCL	23	None
1,1,1-Trichloroethane	190	200	MCL	308	None
Inorganics (Unfiltered):					
Antimony	ND (< 3.0)	3	MCL	6,620	None
Arsenic	8.8	50	MCL	0.4	None
Barium	12.0	1,000	MCL	1,540	None
Beryllium	ND (< 0.1)	1	MCL	1.5	None
Cadmium	1.0	5	MCL	0.6	1.3
Chromium	ND (< 1.9)	50	MCL(1)	17(3)	25(3)
Iron	2,800	None	—	None	None
Lead	ND (< 1.8)	15	(2)	0.8	None
Manganese	990	None	—	None	None
Nickel	8.1	100	MCL	74	None
Mercury	ND (< 0.1)	2	MCL	0.018	None
Selenium	ND (< 6.1)	10	MCL	8	None
Silver	3.1	50	MMCL	None	0.6
Vanadium	ND (< 3.0)	240	HB	370	None
Zinc	ND (< 11.9)	None	—	None	None
Total Suspended Solids	35,000	None	—	None	None
Whole Effluent Toxicity:					
LC 50 100%					
C-NOEC 65% or greater					

Sources: (a) Interim Cleanup Levels and Basis—Table 23 of the ROD (EPA, 1991)

(b) Discharge Limits—Memo from M. Voorhees, EPA Region I, Water Quality Management Section, to R. Leger, Remedial Project Manager, August 9, 1993

Notes: (1) MCL is for hexavalent chromium; concentrations are total chromium. Hexavalent chromium data are not available.

(2) Superfund Policy—Memo from Henry Longest, Director, Office of Emergency and Remedial Response to Patrick Tobin, Director, Waste Management Division, Region IV, Cleanup Level for Lead in Groundwater, June 1990.

(3) Discharge limitations are for hexavalent chromium; concentrations are total chromium. Hexavalent chromium data are not available.

MCL = Maximum Contaminant Level

MMCL = Massachusetts Maximum Contaminant Level

HB = Hazard Based (noncarcinogens)

None = No surface water discharge limit for this parameter was included in the memo by M. Voorhees [Source (b) referenced above].

ND = Not detected in any samples used to establish design basis. Value in parenthesis is the highest reported detection limit for those samples.

LC 50 = Lethal Concentration 50%

C-NOEC = No Observed Effect Concentration

Sludge is pumped once a day from the sludge holding tank into a 12-cubic-foot (0.34 m^3) filter pressure, where it is dewatered to approximately 30 percent solids. The press is mounted on a platform to allow space for sludge collection drums under the press. Filtrate is collected in the filtrate/decant tank and pumped to the clarifier. All tanks which contain water contaminated with VOCs are covered and the headspaces are vented to vapor phase carbon units, the purpose of which is to remove any VOCs which might volatilize into the tank headspaces.

UV Oxidation System

Water from the dual media pressure filters flows to the UV oxidation system for VOC removal. The design basis

system consists of four modular UV oxidation reactors mounted on a single skid. This system is manufactured by Solarchem Environmental Systems, and was used as the design basis system because of the availability of site-specific treatability data for this system.

The use of this system as the design basis was not intended to exclude other UV oxidation systems. The specification for the UV oxidation system was written as a performance-based specification which is flexible enough to allow a number of UV oxidation equipment suppliers to meet the specification, while also obtaining a system which will meet discharge limits in a cost-effective manner. Other systems, including those which use ozone instead of or in conjunction with hydrogen peroxide, are capable of meeting the specification.

Effluent Toxicity

During the treatability study and design phases of the project, the question of effluent toxicity to aquatic organisms arose because the effluent will be discharged to a surface water body rather than reinjected into the aquifer. Hydrogen peroxide is known to cause toxicity to freshwater organisms. Available hydrogen peroxide toxicity data suggests that toxicity may occur at residual hydrogen peroxide concentrations in excess of 5 to 10 mg/l. It therefore became necessary to evaluate options for ensuring that the discharge would not contain residual hydrogen peroxide concentrations high enough to cause effluent toxicity. Three general approaches to this potential problem were considered: 1) use of a different oxidant (such as ozone); 2) installation of a UV/hydrogen peroxide oxidation system which operates with a hydrogen peroxide residual concentration less than that which would cause toxicity; and 3) installation of a module after the UV/hydrogen peroxide oxidation system to remove residual hydrogen peroxide before discharge. All three options were retained in the UV oxidation system specification to allow bidders on the project maximum flexibility in selecting a UV oxidation equipment supplier. This approach provides a benefit by creating competition among the suppliers and avoiding the possibility that only one supplier will be able to meet the specification.

Methods for removing residual hydrogen peroxide were briefly investigated during the treatability study. Solarchem performed a cost analysis of three hydrogen peroxide removal methods vs. providing a UV oxidation system which would operate at a hydrogen peroxide concentration low enough to prevent residual toxicity problems. The primary disadvantage of using a low hydrogen peroxide concentration is that a larger system consisting of twice as many reactors was determined to be needed to attain discharge limits for VOCs. The larger system results in both increased capital costs due to the need for more modules, and increased operating costs due to the need to operate more UV lamps. However, if the larger system is used there is no need to provide a hydrogen peroxide removal module.

The hydrogen peroxide removal methods considered in the cost analysis were Greensand filtration, neutralization with sodium sulfite, and treatment with a specially-formulated activated carbon recently developed by Calgon Carbon Company called Centaur™. It was concluded that it would be more cost-effective to use a large UV oxidation system than it would be to remove residual hydrogen peroxide by any of the methods considered. However, because this conclusion is specific to the Solarchem system, M&E elected to retain the option of a hydrogen peroxide removal module in the specification for the UV oxidation system.

Performance Criteria

The main performance criteria included in the UV oxidation system were as follows:

- Ability to routinely attain discharge limits for the VOCs of concern
- Ability to produce a discharge which does not exhibit toxicity to water fleas or fathead minnows

- For systems which use ozone, the system must provide a minimum of 95% destruction of any VOCs which may be stripped from the water by the ozone.

A major performance criterion for the groundwater treatment plant as a whole is to produce an effluent which is not acutely toxic either to *Ceriodaphnia dubia* (water flea) or *Pimephales promelas* (fathead minnow) at 100 percent strength. This objective is to be attained by keeping the hydrogen peroxide concentration in the discharge to Johnson Creek below 5 mg/l. The contractor is given flexibility within the specification to attain the performance criteria (both toxicity and the individual discharge limits for VOCs) in a number of ways, as long as the primary VOC removal technology is UV oxidation as specified in the ROD [1].

CONCLUSIONS

Bench-scale treatability studies of the UV oxidation technology performed on groundwater from the Groveland Wells Superfund Site showed that the technology could effectively treat site groundwater to meet surface water discharge limits for TCE and other VOCs of concern. Groundwater monitoring performed in the Spring of 1994 indicated that the concentrations of metals in on-site wells did not exceed the interim cleanup levels specified in the 1991 Record of Decision. However, a certain degree of pretreatment to remove suspended solids was still judged to be needed both for operational reasons (to reduce the frequency of cleaning of the UV oxidation system) and to ensure that discharge limits for metals would be met in the plant effluent before it is discharged to Johnson Creek.

The specification for the UV oxidation system was developed using a performance-based approach. The attainment of surface water discharge limits for VOCs and toxicity were the primary performance criteria. Because residual hydrogen peroxide in a discharge has been known to cause toxicity in concentrations as low as 5 to 10 mg/l, it was necessary to address this possibility in the specification. The specification allows the contractor to meet the toxicity performance criterion either by designing the UV oxidation system so that it operates at a hydrogen peroxide concentration below toxic levels, or by including a treatment module for removal of residual hydrogen peroxide before discharge. The specification also allows for use of hydrogen peroxide, ozone, or a combination of the two as the oxidizing agent. The degree of flexibility provided in the specification allows for fair competition among a number of UV oxidation equipment suppliers, while still defining performance criteria which are protective of Johnson Creek.

ACKNOWLEDGMENTS

This work was funded by the U.S. EPA under contract number 68-W9-0036 as part of the remedial design for the Groveland Wells Superfund Site. This work of Mr. Robert Notarfonzo of Solarchem Environmental Systems, who supervised the treatability studies and provided additional support during the design, is gratefully acknowledged.

DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufac-

turer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. EPA. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. EPA.

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APPENDIX E

MANGANESE GREENSAND FILTRATION

IRON REMOVAL VIA MANGANESE GREENSAND FILTRATION

Iron and manganese are two of the most undesirable constituents frequently found in water supplies. Iron removal can be accomplished by treating the ferrous iron with various types of oxidants by various methods.

Manganese greensand filter beds which are regenerated on a continuous feed basis with potassium permanganate (KMnO_4) have been proven to be among the most dependable and cost effective methods used to remove iron and manganese.

This system operates as a standard pressure filter system, with all containment and control advantages, and will remove trace amounts of iron up to about 5 mg/l. Water containing higher amounts of iron is usually retreated prior to the greensand to achieve almost total removal.

Final system design depends on the total content in the water of other reduced state elements. Kisco's design will include consideration of those conditions if known.

GENERAL

Manganese greensand, used for removing soluble iron and/or manganese as well as hydrogen sulfide from well water supplies, is a purple-black filter media processed from Glauconitic greensand.

CONTINUOUS REGENERATION

Continuous regeneration operation is recommended on well waters where iron removal is the main objective with or without the presence of manganese. It involves the feeding of a pre-determined amount of potassium permanganate (KMnO_4) usually in combination with chlorine (Cl_2) directly to the raw water prior to the unit containing manganese greensand. The chlorine should be fed upstream of the KMnO_4 with a contact time of 10-20 seconds if possible. Sufficient chlorine should be fed to produce the desired residual in the filter effluent.

The quantity of Cl_2 and KMnO_4 required can be estimated as follows:

$$\begin{aligned} \text{ppm } \text{Cl}_2 &= \text{ppm Fe} \\ \text{ppm } \text{KMnO}_4 &= 0.2 \times \text{ppm Fe} + 2 \times \text{ppm Mn} \end{aligned}$$

Without Cl_2 the KMnO_4 demand can be estimated as follows:

$$\text{ppm } \text{KMnO}_4 = 1 \times \text{ppm Fe} + 2 \times \text{ppm Mn}$$

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MANGANESE GREENSAND FILTRATION

SUGGESTED OPERATING CONDITIONS

Backwash - The flow rate should be sufficient to produce approximately a 40% bed expansion.

Capacity - This is normally 500-700 grains/sq. ft. of bed area based on potassium permanganate demand. In addition to the manganese greensand an anthracite bed with a minimum depth of 15 inches is required. In any case the pressure drop should not exceed 10-12 psi.

Flow Rate - Normal flow rates with continuous regeneration are 2-5 gpm/sq. ft. Higher concentrations of iron and manganese usually require lower flow rates for equivalent run lengths. Rates in excess of 5 gpm/sq. ft. can be tolerated but a pilot unit should be operated to determine the effluent quality and run length.

The run length between backwashes can be estimated as follows:

Example: What is a run length on a water containing 1.7 ppm iron and 0.3 ppm manganese at a 4 gpm/sq. ft. operating rate?

$\text{KMnO}_4 \text{ demand} = (\text{Fe}) 1.7 \times 1 + (\text{Mn}) 0.3 \times 2 \text{ or } 2.3 \text{ ppm}$

$2.3 \text{ divided by } 17.1 = 0.13 \text{ grains/gal. (gpg)}$

$700 \text{ grains/sq. ft. divided by } 0.13 \text{ gpg} = 5200 \text{ gal/sq. ft.}$

$5200 \text{ gal/sq. ft. divided by } 4 \text{ gpm/sq. ft.} = 1300 \text{ min.} = 21.7 \text{ hours}$

Therefore the backwash frequency is approximately every 20-24 hours of operation.

INTERMITTENT REGENERATION

This method of operation is recommended on well waters where only manganese or manganese with small amounts of iron is to be removed. Treatment involves the regeneration of manganese greensand with a predetermined amount of KMnO_4 after a specified quantity of water has been processed. With this method the pressure drop is lower because the manganese is removed by contact oxidation on the manganese greensand. This eventually results in a larger manganese greensand grain size and bed growth, which can be removed either physically, by backwashing at a higher rate, or by sluicing from the bottom of the bed via suitable tank connection.

MANGANESE GREENSAND FILTRATION

SUGGESTED OPERATING CONDITIONS

Backwash Rate - This flow rate should be sufficient to produce approximately a 40% bed expansion.

Regeneration

KMnO ₄ Dosage	1.5 - 2.0 oz. KMnO ₄ /cu. ft.
KMnO ₄ Solution Strength	2-4 oz./gallon
KMnO ₄ Regeneration Rate	0.25 gpm/cu. ft.
KMnO ₄ Regeneration Time	30 minutes optimum
KMnO ₄ Regeneration Volume	7.5 gal/cu. ft.
Rinse Rate	1 gpm/cu. ft.
Rinse Volume	40 gal/cu. ft. or until all traces of KMnO ₄ are gone

NOTE: RECYCLE OF RINSE WATER WILL CONSERVE KMnO₄ AND RINSE WASTE WATER.

Capacity - 300 grains/cu. ft. Prechlorination is recommended especially if Mn is present.

Pressure Drop - Maximum pressure drop is 12 psi. If this pressure differential is reached before the capacity for Mn is obtained, manganese greensand can be backwashed without regenerating.

Flow Rate - 2-5 gpm/sq. ft. or 1-2 gpm/cu. ft. For higher flow rates contact supplier.

PHYSICAL CHARACTERISTICS

Physical Form	Black, nodular granules, shipped in a dry form
Shipping Weight	85 pounds per cubic foot net
Screen grading (dry)	18 to 60 mesh
Effective Size	0.30 to 0.35 mm
Uniformity Coefficient	1.40 to 1.55

Suggested operating conditions:

pH Range	6.1 - 8.5 (See detailed information)
Maximum Temperature	Above 100°F contact supplier
Maximum Pressure Drop	12 psi
Backwash Rate	See detailed information
Service Flow Rate	See detailed information
Minimum Bed Depth	24" (18" in dual beds)

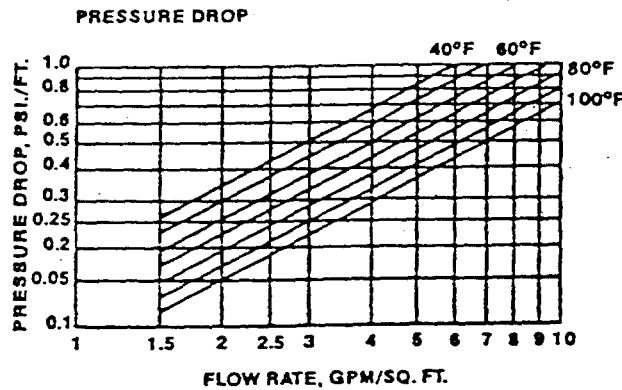
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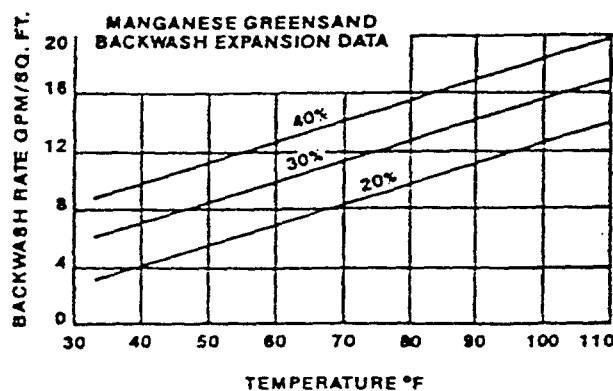
MANGANESE GREENSAND FILTRATION

HYDRAULIC CHARACTERISTICS

Pressure Drop - The approximate pressure drop for each foot of manganese greensand bed depth on a clean bed is shown in the graph. Pressure drop increases as run progresses. Do not exceed 12 psi.



Bed Expansion During Backwashing - After each service cycle the manganese greensand should be backwashed for 8-10 minutes to remove the suspended material collected during the run. The manganese greensand should be expanded a minimum of 35% during backwash. The bed expansion characteristics are shown in the graph.



Raw waters having a pH of 6.2 or higher can be passed through manganese greensand without pH correction; waters having a pH lower than 6.2 should be pH corrected to 6.2 - 6.5 before passing through the manganese greensand. If a pH higher than 6.5 is desired in the water system, the additional alkali should be added after the filters due to the adverse reaction (formation of a colloid) that sometimes occurs with the iron and alkali with pH over 6.5.

MANGANESE GREENSAND FILTRATION

KMnO₄ Solution Strength - With continuous regeneration operation the KMnO₄ can be any concentration up to 4 oz/gallon. See chart below for solubility of KMnO₄:

Solubility of KMnO₄ in Water

Temperature oF	Temperature oC	g./100 ml.	lb./gal.
32	0	2.78	0.23
68	20	6.51	0.54
104	40	12.53	1.05

Removing Fines - Although the manganese greensand is thoroughly washed before shipment, it is recommended that before it is put into service the material be thoroughly backwashed and the top layer of finer material be removed. This is especially important if anthracite is placed on top of the manganese greensand. Each bag contains sufficient material to compensate for removing about 1" of finer material.

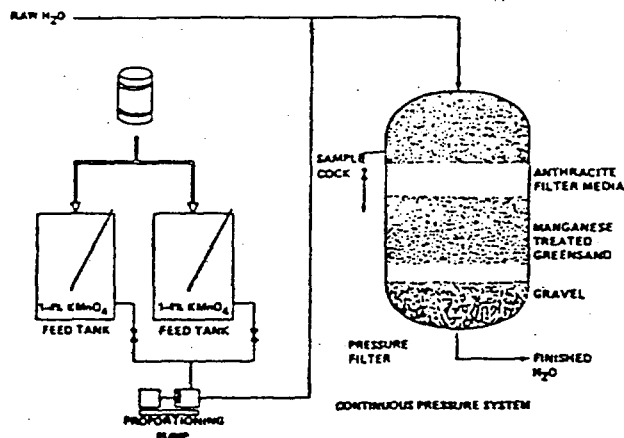
Regeneration - Although the manganese greensand is thoroughly regenerated before shipment, it is necessary prior to use to regenerate with potassium permanganate solution contacting the bed for approximately one hour. Usually 2 oz. of potassium permanganate per cubic foot is adequate. The filter must be rinsed of all traces of permanganate after regeneration.

Sometimes during the intermittent regeneration more or less than the equivalent amount of potassium permanganate is required. This is an oxidation-reduction reaction. If there are other reducing substances in the water more permanganate than the equivalent amount may be required. Conversely, where there are oxidizing substances in the water such as oxygen and/or chlorine under certain situations less potassium permanganate may be required. This can best be determined by close surveillance of operating data. Theoretically 300 grains of manganese is equivalent to 1.3 oz. of potassium permanganate per cubic foot.

Permanganate Detector - A properly operated manganese greensand filter should never have potassium permanganate or "pink water" in the treated water supply. If, however, it is felt that insurance against pink water should be provided use detectors to signal an alarm or shut down a system should pink water be detected in the treated water supply.

MANGANESE GREENSAND FILTRATION

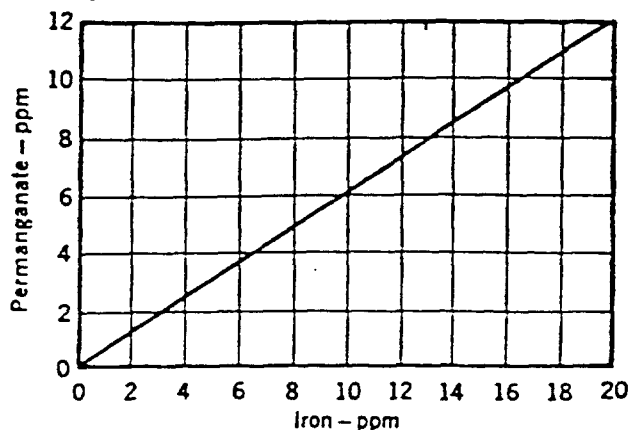
Continuous KMnO₄ Feed in Manganese-Greensand System



The following chart may be helpful in visualizing a workable flow diagram for handling iron, manganese and hydrogen sulfide removal. Selection is made on the basis of the total potassium permanganate demand, best determined at the jobsite, using a KMnO₄ demand test kit. The KMnO₄ demand also can be approximated from a water analysis by determining the sum of the following:

Iron (ppm as Fe) x 0.75	=	
Manganese (ppm as Mn) x 2.0	=	
Hydrogen Sulfide (ppm as H ₂ S)	=	
Organic Matter (ppm O.M.I.)	=	
Approximate KMnO ₄ demand		

Permanganate Demand Curve for Oxidation of Ferrous Iron.



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The potassium permanganate demand may also be calculated from the graphs shown above which illustrate the relationship between ferrous iron, manganous manganese, hydrogen sulfide and potassium permanganate demand.

Oxidation System Selection Chart

KMnO ₄ Demand	Type of Supply	Type of System
0.2 - 5.0 ppm	City water, piped-in supply, or partially treated supply.	Figure No. 10
0.2 - 5.0 ppm	Private well supply or municipality well.	Figure No. 11
5.1 - 15.0 ppm*	Private well supply.	Figure No. 12
5.1 - 15.0 ppm*	Municipal supply.	Figure No. 13
Over 15 ppm*	Private or Municipal supply.	Figure No. 14

* Economic considerations dictate application of aerators. Many waters having much lower than 15 ppm potassium permanganate demand, justify aeration to reduce costs. Since approximately 90% of the iron and 15% of the manganese can be removed by aeration, thus reducing the permanganate demand, calculation can be made to determine the estimated saving. The savings in many cases will more than pay for an aerator, especially where large quantities of water are to be treated.

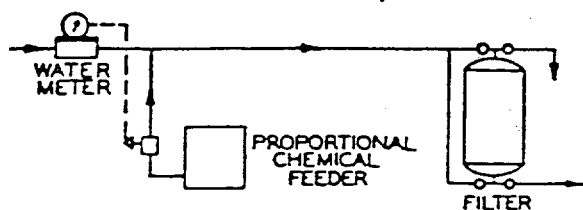


Fig. 10. System using meter-paced proportional chemical feeder.

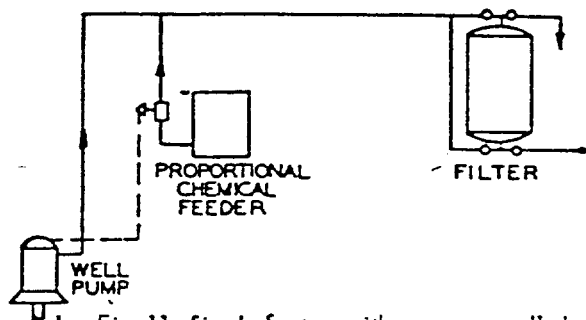


Fig. 11 Simple System with pump controlled simultaneously with well pump operation.

MANGANESE GREENSAND FILTRATION

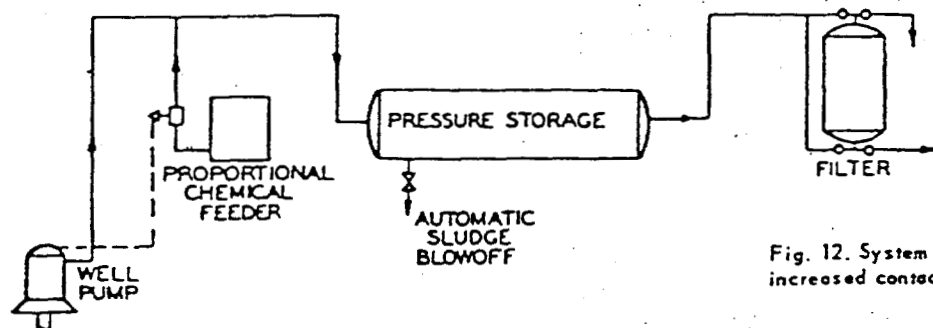


Fig. 12. System with pressure tank for increased contact time and/or sludge removal.

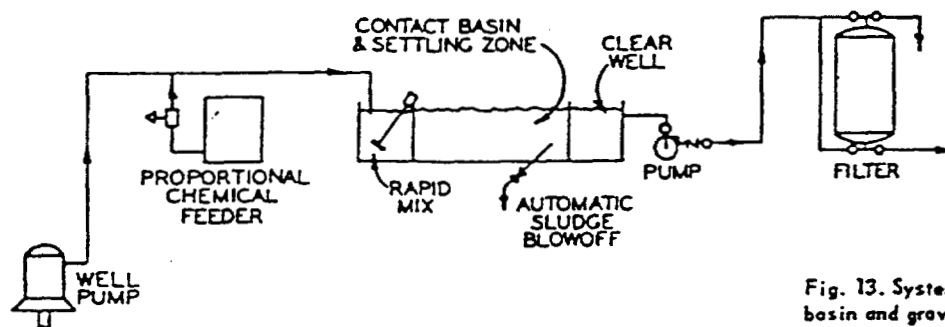
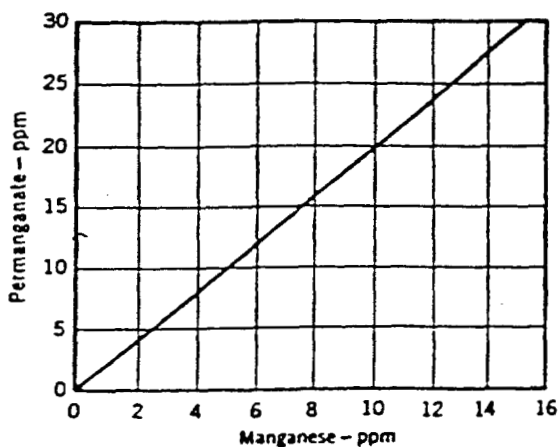
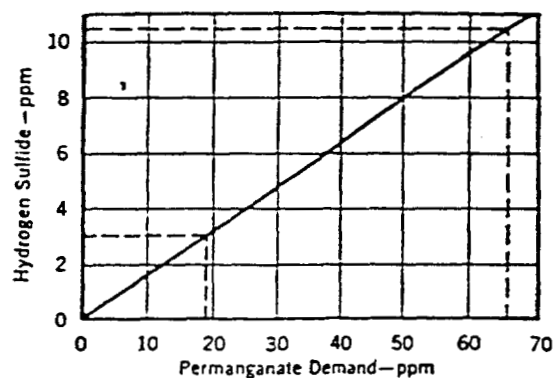


Fig. 13. System employing contact basin and gravity settling zone.

Permanganate Demand Curve for Oxidation of Manganous Manganese.



Permanganate Demand Curve for Conversion of Hydrogen Sulphide.



Note - 8/1/96

Telephone conversation with M. Arland Green

ΔP across bed of stream - filter an backwash

The initial head loss will be equal to the pressure drop at the end of the filtration cycle.

• If the clean water ΔP is 6.2519 and the ΔP needed to backwash is 13.2519, the final head loss $\Delta P = 13.2519$.

• The initial head loss ΔP will be 6.2519.

• The water head loss will drop to zero when the filter is backwashed.

(intentionally blank)